
CAN DUBAI GO GREEN?
VANISHING ARCTIC CULTURE
THE TROPHY HUNT DEBATE
NATIONAL GEOGRAPHIC
THE MAKING OF AN ICON
BECOMING JANE
OCTOBER 2017

Kuroiwa's Ground Gecko *(Goniurosaurus kuroiwae)*
Size: Body length, 14 - 16 cm (5.5 - 6.3 inches) **Weight:** 10 - 11 g (0.35 - 0.39 oz) **Habitat:** Limestone in areas near rivers and brooks, as well as caves **Surviving number:** Unknown

Photographed by Shawn Miller

WILDLIFE AS CANON SEES IT

To stay or to go? Kuroiwa's ground gecko sometimes finds waiting to be a good strategy as insects simply wander into range. Unlike most lizards, however, this gecko does not stick to just one hunting technique, but also roams in search of food. The temperature can influence its movements: from October to May, it only becomes active when the mercury rises high enough. But whether it stays still or sallies forth, the gecko is forced to face serious threats in the form of habitat loss, introduced predators and the illegal pet trade.

As Canon sees it, images have the power to raise awareness of the threats facing endangered species and the natural environment, helping us make the world a better place.

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OCTOBER 2017 • VOL. 232 • NO. 4 • OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

FRONT

WORLD FOOD DAY
Where calories count

VISIONS

EXPLORE
Animals: dogs and cats, bees and bears – and wild creatures like the slow loris (above) that suffer in the illegal pet trade.

FEATURES

On the Cover To document Jane Goodall's discoveries about chimps, National Geographic sent photographer Hugo van Lawick. First he posed her for photos like this one. Later he proposed.
Photo by Hugo van Lawick

Corrections and Clarifications
Go to *natgeo.com/corrections*.

PHOTOS: EVGENIA ARBUGAEVA (NENETS); JOEL SARTORE, NATIONAL GEOGRAPHIC PHOTO ARK (SLOW LORIS)

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ELSEWHERE

TELEVISION

THE MARATHON RECORD QUEST

Completing a marathon – 26.2 miles – in under two hours is a feat that has eluded runners. This past May, Eliud Kipchoge came within 26 seconds of breaking the barrier. The experiences of Kipchoge and other elite runners – their personal lives and dreams as well as their training – are chronicled in the new documentary *Breaking2.* Created through a Nike–National Geographic partnership, the program will air at 8/7c on September 20 on National Geographic.

TRAVELER MAGAZINE

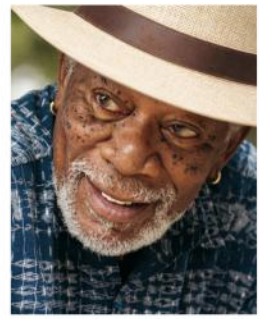
JOURNEYS OF A LIFETIME

Dive into Sicily on a delicious cultural journey. Explore intriguing India five different ways, including camping in the Himalaya. And surprise yourself with 15 amazingly achievable adventures, in the October/November issue of *Traveler* magazine.

TELEVISION

MORGAN FREEMAN'S *THE STORY OF US*

Power, belief, freedom, love – they can help unite societies or splinter them. In *The Story of Us,* Morgan Freeman travels the globe to see these forces at work. The six-part series airs at 9/8c Wednesdays starting October 11 on National Geographic.



NAT GEO WILD

HOUSE CALLS WITH THE YUKON VET

Michelle Oakley cares for animals of all kinds, domesticated and wild, in the Yukon and Alaska. The series *Dr. Oakley, Yukon Vet* returns for a fifth season with eight new episodes. It airs at 9/8c Saturdays starting October 14 on Nat Geo WILD.

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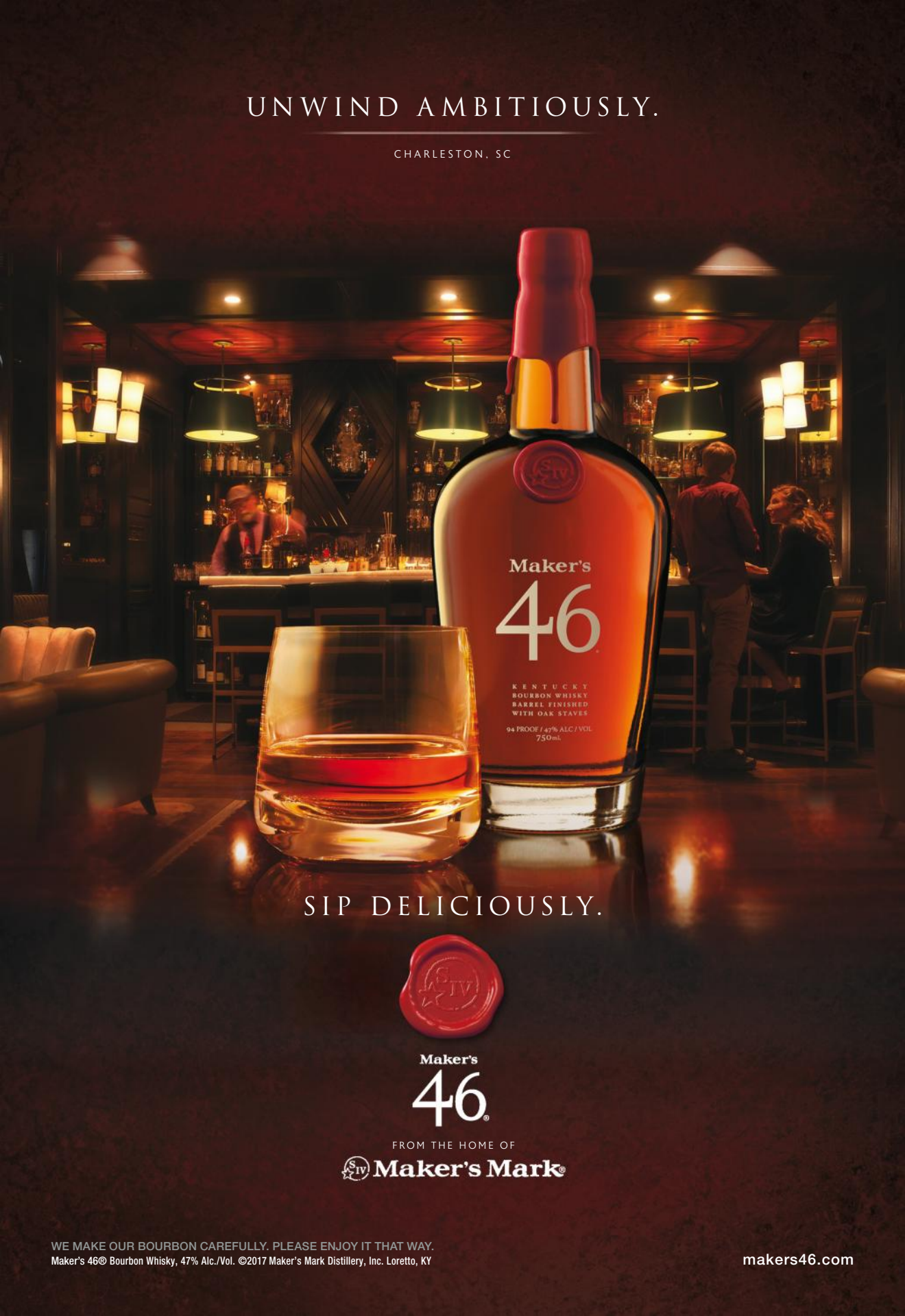
PHOTOS: KEITH LADZINSKI (RUNNER); JUSTIN LUBIN (FREEMAN)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SUSTAINABILITY KEY FOR CITIES

In 1950 less than a third of the world's people lived in cities. Today more than half do. By 2050 two-thirds of humanity is expected to reside in urban areas.

Many sprawling, densely populated areas are all about "un": unplanned, unhealthy, unsustainable. I remember feeling the "un" when my husband and I were in New Delhi in November 2016: In the capital city of the second most populous nation on Earth, the pollution was so bad that schools had to close because it wasn't safe for kids to be outdoors.

The growth of cities has produced some of the most complex issues of our time. It's a phenomenon that creates disruption—but also great reason for hope.

At *National Geographic* we're known for telling stories about vast and open places. Increasingly, however, we're documenting the growth of the world's cities to explore how this trend is changing us.

That's why we've brought you stories from Detroit and from Lagos, Nigeria. And it's why we've launched Urban Expeditions—a series of case studies on innovative cities—with a grant from United Technologies.

In this month's issue writer Rob Kunzig and photographer Luca Locatelli take us to Dubai, a "sprawling efflorescence of concrete, glass, and steel that has sprung up over the past three decades on the scorched sands of Arabia." Improbably it's aiming to become a green city. Built for cars, it's now developing more walkable districts and public transportation. It's transitioning to solar power and finding ways to reduce per capita energy and water consumption—right down to equipping mosques with low-flow faucets to save water during the ritual ablutions before prayers.

When we see cities straining against natural limits in the way that Dubai does so dramatically, it's tempting to ask: Should this city even be here? Kunzig posed that question to environmental advocate Tanzeed Alam. "That's the wrong question," Alam replied. "It's more about accepting where we are today... How do we make cities better?"

Susan Goldberg, *Editor in Chief*

The villas above are part of a 114-acre development in Dubai called the Sustainable City. Each villa is equipped with solar panels. The buildings are oriented to shade each other part of the day; limiting direct sun exposure allows the villas to use smaller air-conditioning units.

See more coverage of cities and sustainable growth solutions online at *natgeo.com/urbanexpeditions.*

PHOTO: LUCA LOCATELLI


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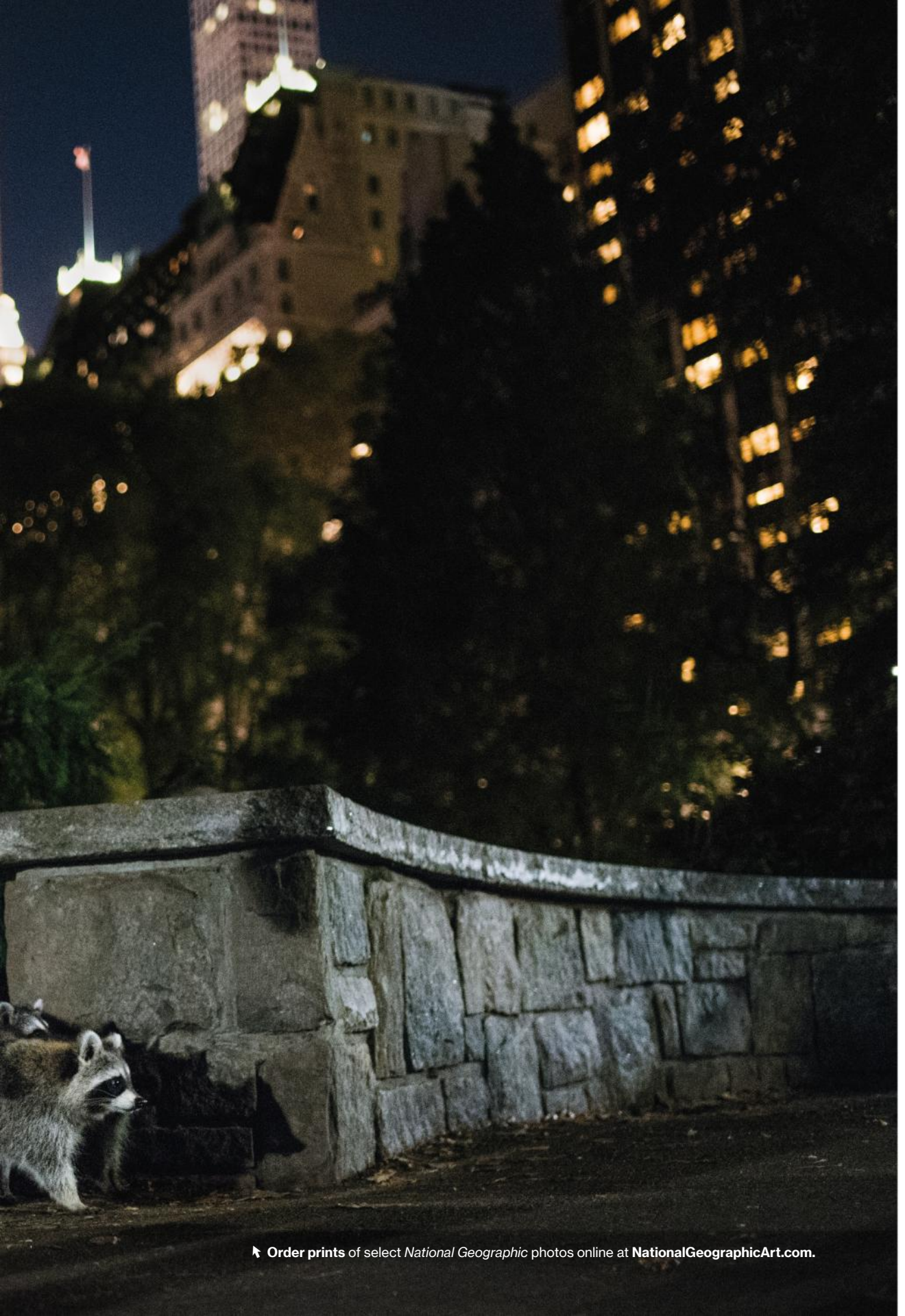
VISIONS

United States
Raccoons cluster near a path in New York's Central Park, hoping for handouts from nocturnal visitors. City officials say feeding the omnivorous mammals is risky – raccoons can carry rabies – and unnecessary, given how resourceful they are. It's also illegal.

PHOTO: HILARY SWIFT



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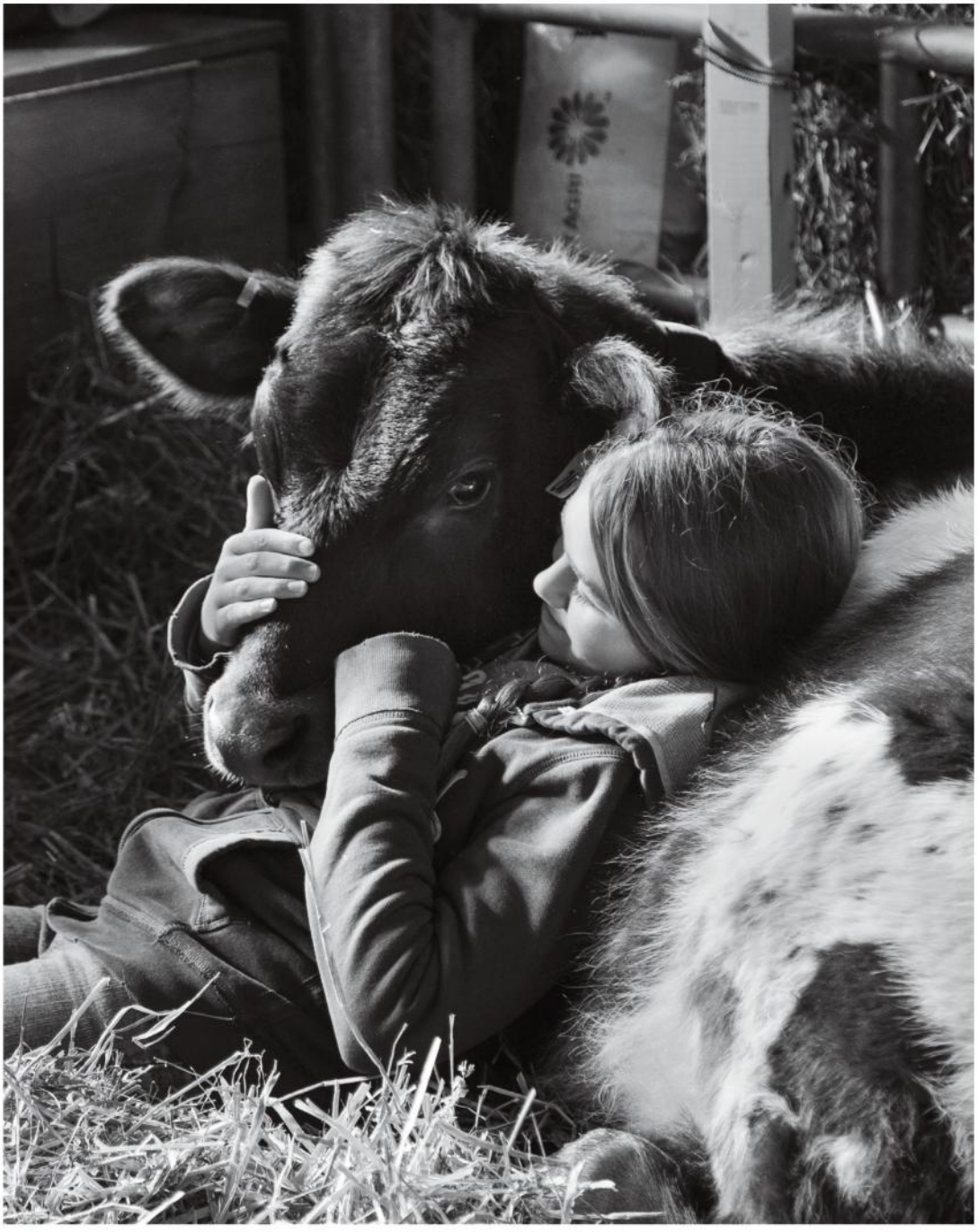

WHY WE LOVE PETS

ASSIGNMENT The animals we live and bond with can affect our emotions. We asked to see the power of pets in your life.

Jennifer MacNeill
East Petersburg, Pennsylvania

While visiting the Pennsylvania Farm Show, MacNeill walked around photographing children exhibiting the livestock they've raised. In one barn she saw a girl lying with her heifer. Many of the animals are auctioned off. This girl was allowed to keep hers.

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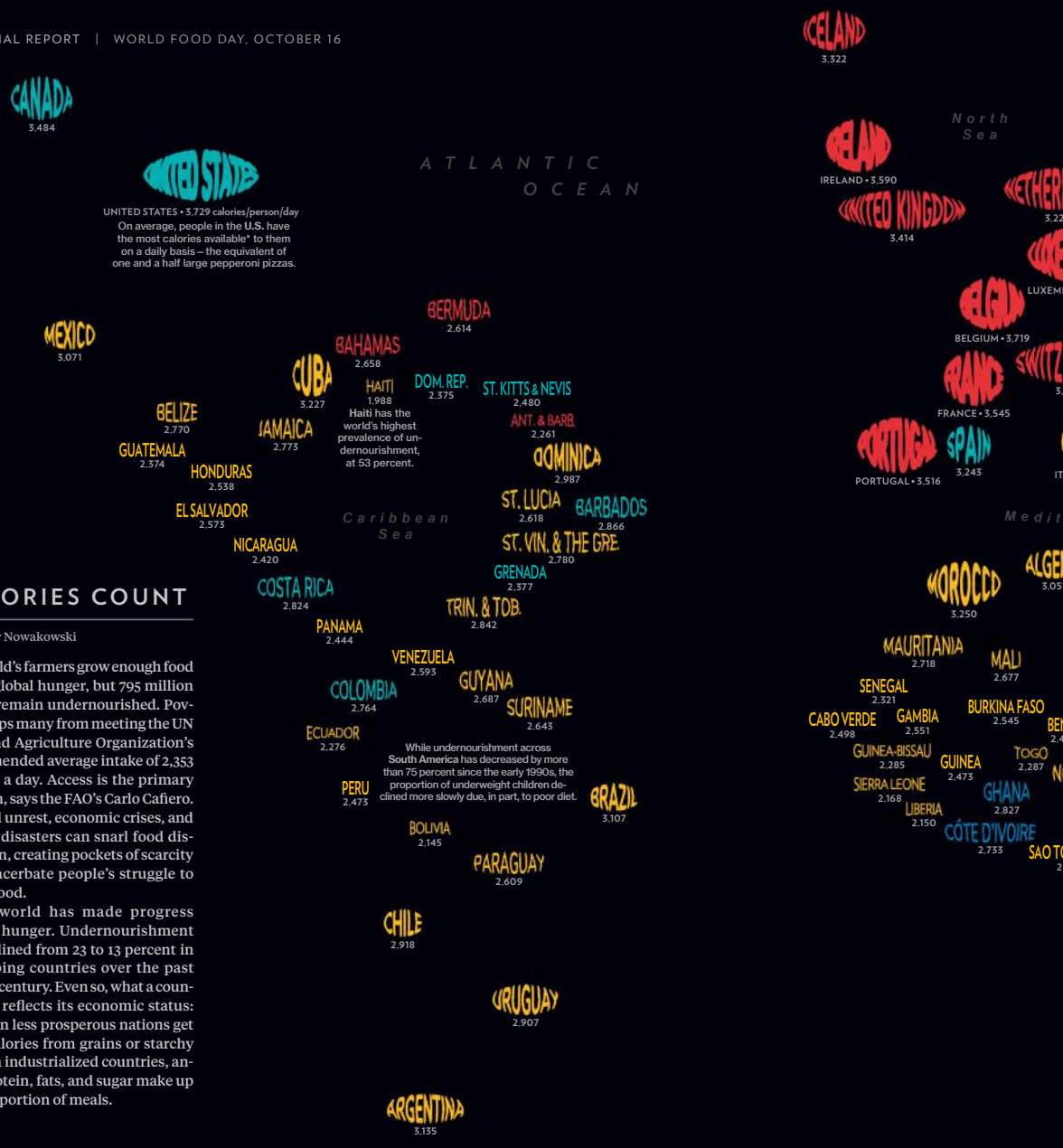
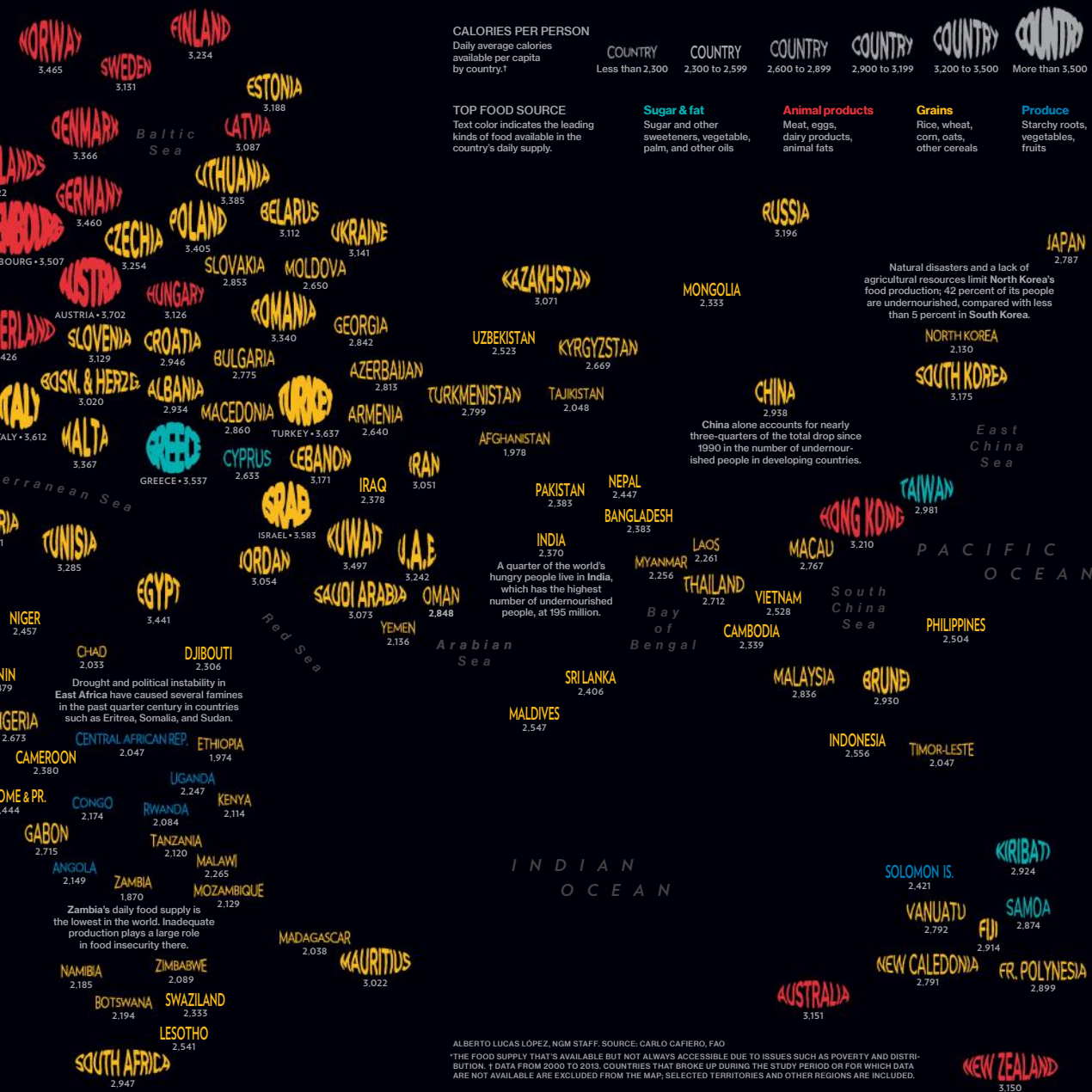
CALORIES COUNT

By Kelsey Nowakowski

The world's farmers grow enough food to end global hunger, but 795 million people remain undernourished. Poverty keeps many from meeting the UN Food and Agriculture Organization's recommended average intake of 2,353 calories a day. Access is the primary problem, says the FAO's Carlo Cafiero. Political unrest, economic crises, and natural disasters can snarl food distribution, creating pockets of scarcity that exacerbate people's struggle to access food.

The world has made progress against hunger. Undernourishment has declined from 23 to 13 percent in developing countries over the past quarter century. Even so, what a country eats reflects its economic status: People in less prosperous nations get more calories from grains or starchy roots; in industrialized countries, animal protein, fats, and sugar make up a larger portion of meals.





ALBERTO LUCAS LÓPEZ, NGM STAFF. SOURCE: CARLO CAFIERO, FAO

*THE FOOD SUPPLY THAT'S AVAILABLE BUT NOT ALWAYS ACCESSIBLE DUE TO ISSUES SUCH AS POVERTY AND DISTRIBUTION. † DATA FROM 2000 TO 2013. COUNTRIES THAT BROKE UP DURING THE STUDY PERIOD OR FOR WHICH DATA ARE NOT AVAILABLE ARE EXCLUDED FROM THE MAP; SELECTED TERRITORIES AND OTHER REGIONS ARE INCLUDED.

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DO YOU REALLY KNOW YOUR CAT?

By Nina Strochlic

For those who've long wondered if their cats regard them merely as kibble dispensers, a report in the journal *Behavioural Processes* should be reassuring. In a study that exposed adult cats to four categories of stimuli—food, toy, scent, and human social interaction—the majority of cats preferred human interaction over all other options, even food.

This type of research "was done on dogs in the '90s" but not on cats until now, says Oregon State University's Kristyn Vitale Shreve, a co-author of the study. "We're trying to catch up." Cats are stereotyped in the U.S. as untrainable and unsocial, she says, but they can be taught using the same general principles as dogs—so long as the incentives are right. Vitale's next study will research how to use cats' preferences to train them.

What else don't we know about cats? For instance, is the kitten in this photograph scared or playful? (Answer: It's leaping at a toy dangling in front of the camera.) Cat emotions are notoriously hard to decipher: A new study in Italy by veterinary scientists found that most owners don't recognize the range of signals cats use to show stress. "Dog owners know more about dog behavior," says author Chiara Mariti. In contrast, cat owners often interpret their pets' behavior as normal to the species, rather than a signal about how they're doing.

Scientists are working hard to solve such feline mysteries. Last year a Swedish university launched a five-year study into human-cat communication. The goal: to see if cats react to different ways humans speak to them, and to translate meows into emotions and desires.

THE SCIENCE OF CATS

Independent Streak: When dogs and cats were tasked with solving a puzzle, a study in the *Journal of Comparative Psychology* found, dogs looked to humans for help with an impossible task while cats kept trying on their own.

Cat Transit: By analyzing mitochondrial DNA in the remains of some 200 ancient cats, researchers in France found that felines spread across the world first with farmers from the Fertile Crescent and then with sailors trading around the globe.

PHOTO: SETH CASTEEL

HOW VERTEBRATES GOT THEIR COATS

By Michael GresÜo

From scales to feathers to fur, vertebrates clothe themselves in a dazzling variety of textures and hues. But scientists have shown that many of those coverings emerge from the same anatomical hardware.

Biologists have long known that feathers and hairs both start as structures called placodes. In reptiles, however, biologists had found distinct skin areas that yielded scales but no placodes. The absence proved puzzling, since birds are more closely related to reptiles than to mammals. Had birds and mammals evolved placodes independently? Or had today's reptiles discarded them?

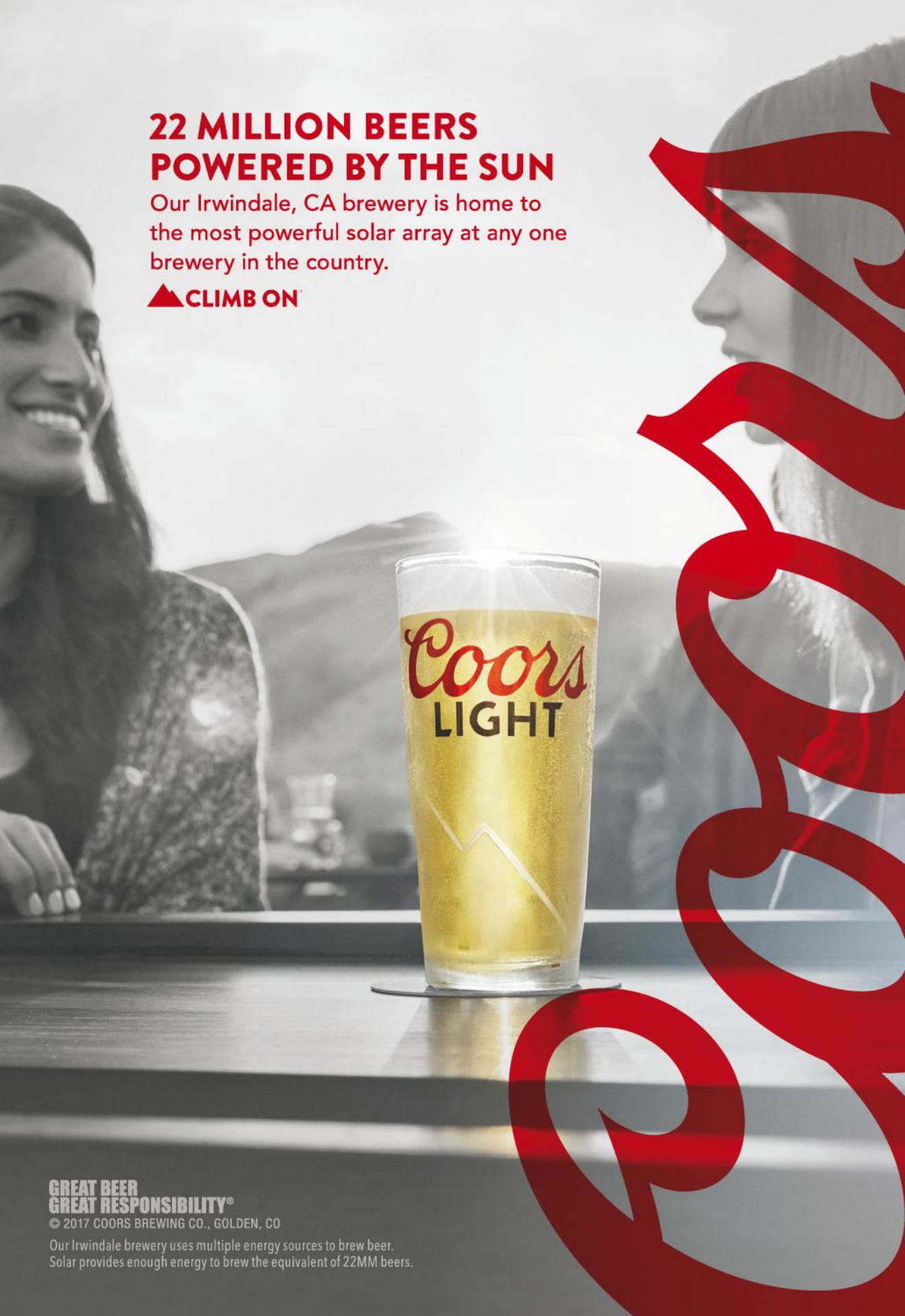
Then University of Geneva biologist Michel Milinkovitch visited an Italian animal fair, found scaleless, "naked" bearded dragons for sale—and a third scenario emerged. When he compared the naked lizards and their scaly kin, he saw to his shock placode-like bumps dotting the skin of scaled embryos. Naked embryos, however, stayed smooth.

In 2016 Milinkovitch announced that the bumps were indeed placodes, placing the structures in reptiles', birds', and mammals' common ancestors more than 300 million years ago. And since placodes buzz with genes that also sculpt teeth and fish scales, some scientists think that placodes arose in the earliest vertebrates—a "remarkable conservatism," argues Université Grenoble Alpes biologist Danielle Dhouailly, going back 420 million years.

Milinkovitch also found that naked bearded dragons lack scales because they're missing working copies of a gene crucial to placode formation. As he noted with a chuckle, that brings his discovery full circle: "This animal doesn't have scales, because it cannot make what people thought didn't exist in reptiles."

What the fashionable vertebrates are wearing, from left: the fur of a leopard, the feathers of a male Lady Amherst's pheasant, and the scales of a rock python

PHOTOS: DAVID LIITTSCHWAGER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GETTING INSIDE FIDO'S HEAD

By Nina Strochlic

When a dog leaped from a helicopter to accompany the U.S. SEAL team on the raid of Osama bin Laden's complex in 2011, Gregory Berns was inspired. "I thought, If dogs can jump out of helicopters, we can train them to go into an MRI," he recalls. The next year the neuroscientist launched the Dog Project at Emory University, which was the first to teach dogs to lie still without sedation in an MRI scanner so their brains can be studied.

By peering into a dog's brain, researchers are able to see how it reacts to stimuli like hand signals, sounds, and smells. Activity in the reward center can show whether dogs prefer human affection to food (most like both equally), and which ones may not be fit for duty as service dogs (if, for example, they get too anxious or excited with strangers).

Now Berns wants to know how dogs learn human language: "When a dog hears a word, is it just an auditory stimulus, or does it go deeper to have some sort of meaning?" To find out, he's spent a year watching dogs' brain activity while they hear familiar and nonsense words.

Because canine brain structures and processes are potentially as unique and complex as ours, it will require years of tests to decipher how they work. "When we talk about 'dogs,' that's about as descriptive as talking about 'people,'" says Berns. "Dogs are just as different from each other as humans are."

THE SCIENCE OF DOGS

Baby Talk Like human infants, puppies respond better to high-pitched human speech than to low-pitched. Researchers in New York and France found that pitch may actually help puppies learn words – but by adulthood, dogs no longer prefer a higher octave.

In the Groove
Humans and their canine companions both find solace in music. Researchers from the University of Glasgow put on five different playlists for kennel dogs while monitoring their stress. Although reactions differed, the music had a calming effect – particularly soft rock and reggae.

Test Tube Pups
After decades of testing, researchers at the Smithsonian Institution and Cornell University produced a litter of pups using in vitro fertilization. Scientists hope to apply the technique to tackle genetic diseases that dogs and humans share.

In the Family When it comes to social intelligence, toddlers show patterns more similar to dogs than to chimpanzees, even though chimps are more closely related to humans. In some communication tasks, University of Arizona scientists found that both dogs and kids performed better than chimps.

PHOTO: ELKE VOGELSANG

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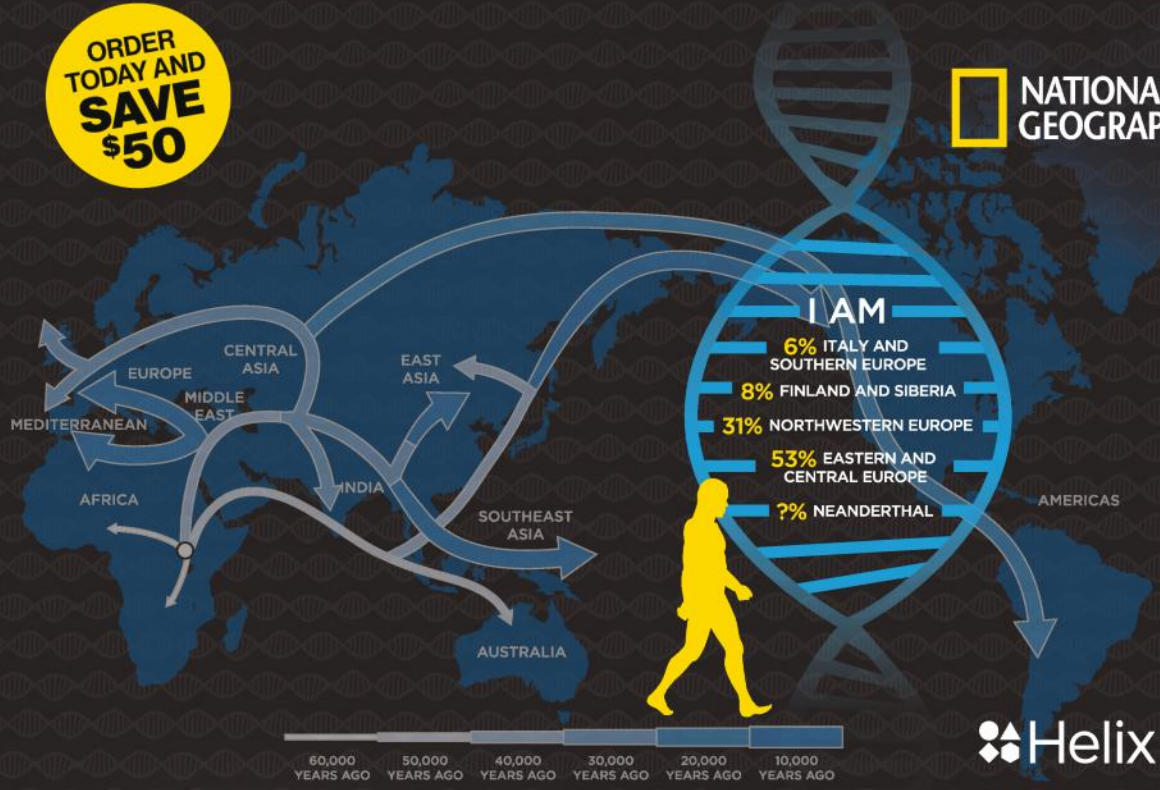

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SPOTS AND STRIPES ARE NOT SO BLACK-AND-WHITE

By Natasha Daly

Think of flamboyance in the animal kingdom, and a colorful menagerie springs to mind: a parrot's rainbow plumage or the showy scales of a tropical fish. Mammals tend to be less colorful than other animal groups, but some are strikingly attired in black-and-white.

What purpose do such high-contrast patterns serve? The color scheme's utility isn't always apparent. Deciphering what zebras gain from having stripes has puzzled scientists for more than a century.

To try to solve the mystery, wildlife biologist Tim Caro of UC Davis spent more than a decade studying zebras in Tanzania. He ruled out theory after theory—stripes don't keep them cool, stripes don't confuse predators—before finding an answer. In 2013 in the savanna, he set up flytraps covered in zebra skin and, for comparison, others draped in wildebeest skin. He saw that flies didn't seem to like landing on the stripes. After more research he concluded that stripes can literally save a zebra's hide from disease-carrying pests.

Black-and-white may not be as eye-popping as fluorescent scales—but it can pay off for the mammals that sport it.

GIANT PANDA

Communicative Patchwork

Recent insights into panda coloring have come from studying each body part separately. Black ears indicate ferocity, and distinct eye patches aid in individual recognition. The panda's white body camouflages it against snow, while its dark limbs help it hide in forests, a compromise derived from its poor bamboo diet. Bamboo doesn't let pandas build up enough fat to hibernate, forcing them to spend winters in the snow.

Why Black-and-White?

- Warning
- Communication (within own species)
- Concealment
- Physical regulation

DAISY CHUNG, NGM STAFF; KELSEY NOWAKOWSKI
SOURCE: TIM CARO, UNIVERSITY OF CALIFORNIA, DAVIS

BADGER

A Ferocious Mask

Even when a badger is crouched in its burrow, its bold facial stripes may be seen. Zoologists say the warning coloration helps the small mammal deter predators.

BLACKBUCK (MALE)

Hiding in His Own Shadow

In bright sun the buck's white stomach counteracts the shadow cast by his back, allowing the animal to appear one color and two-dimensional.

ZEBRA

Stripes, No Bites

Zebras' thin coats make them more vulnerable than long-haired animals to biting flies that carry disease. But the coats' stripes deter flies from landing on zebras, for reasons that scientists are still investigating.

SKUNK

Black, White, and Smelly

Depending on the species, black skunks may wear white spots that act as camouflage or white stripes that signal enemies to beware their smelly spray.

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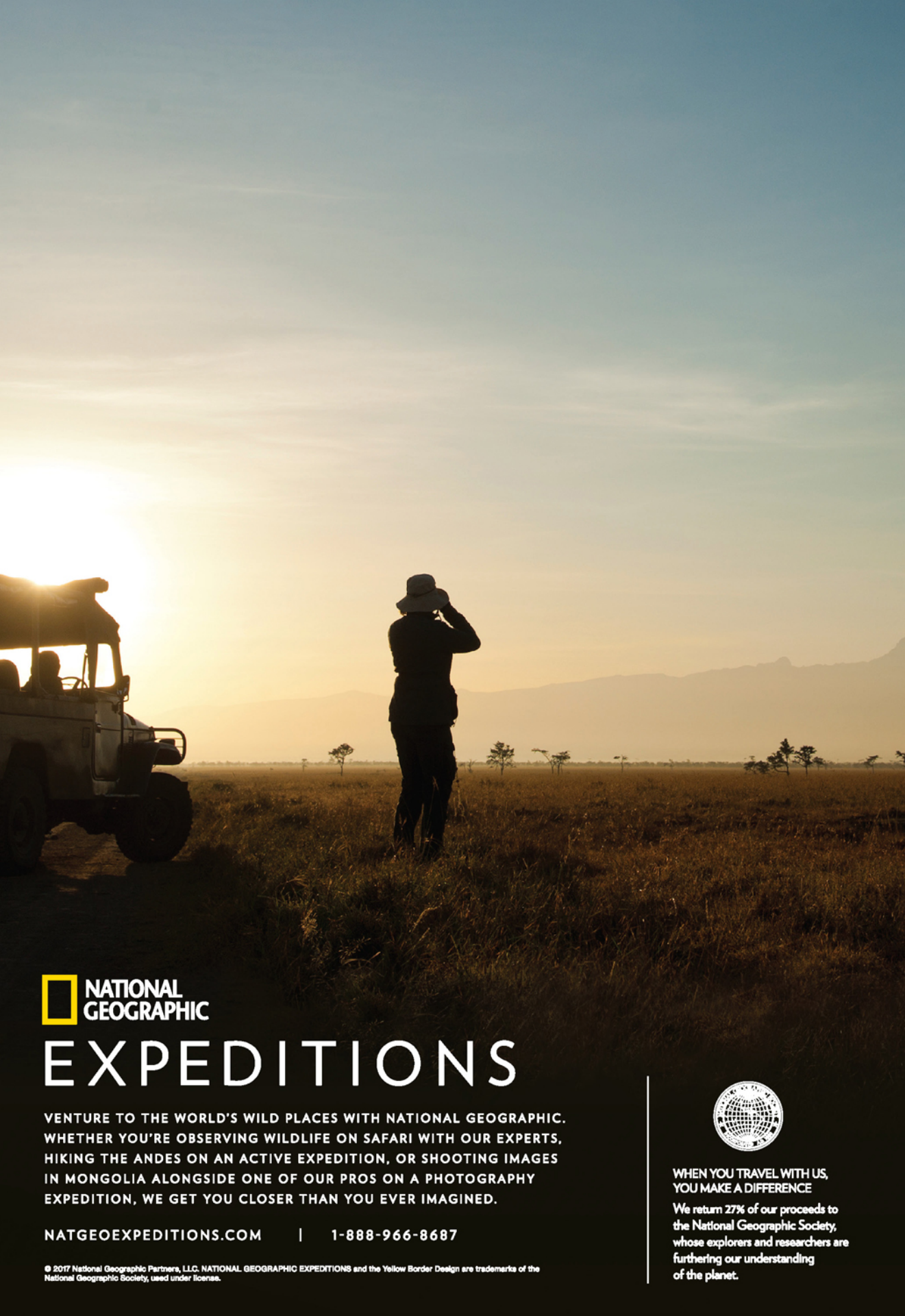

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BORN TO BE WILD

By Jani Actman

After videos of slow lorises (below) being tickled and fed rice balls in captivity swept the Internet, the wide-eyed animals shot to viral fame. The YouTube videos generated thousands of comments about the primate's adorable looks, but they also highlighted a grievous threat facing slow lorises: demand for them as pets.

All species of slow lorises are supposed to be protected by local laws in southern Asia and by the Convention on International Trade in Endangered Species (CITES), a treaty that aims to prevent trade that could threaten wild species' survival. Still, countless slow lorises are captured each year from their rain forest habitat and sold online, across borders, or to local wildlife markets.

Customers find them irresistible, but these primates don't fare well as pets. Before they're sold, most undergo a painful process to remove their sharp teeth—and circumstances don't improve from there. In a 2016 study, researchers from Oxford Brookes University examined a hundred online videos of pet lorises and concluded that all the animals were distressed, sick, or exposed to unnatural conditions. "They're quite sensitive," says Christine Rattel of International Animal Rescue, which runs a slow loris rescue program in Indonesia. "They are nocturnal, small animals that don't like to be handled."

It's uncertain how many slow lorises remain in the wild, but conservationists say populations have declined because the pet trade continues to run rampant. Habitat loss also has taken a toll, as has poaching for traditional Asian medicine, which ascribes therapeutic properties to the animals' body parts. An ongoing pet trade "would really push lorises to the brink of extinction," Rattel says.

They're hardly the only wildlife facing this threat. Cheetahs, lions, and other famed species end up in basements and backyards, as do lesser known creatures such as the ball python and long-tailed macaque.

"The pet trade is probably one of the most devastating parts of the wildlife trade," says wildlife-trafficking expert Chris Shepherd. But it's "getting the least amount of attention."

RESCUING THE SLOW LORIS

This female *Nycticebus bengalensis* was photographed in 2014 at the Endangered Primate Rescue Center, located in a national park in northern Vietnam. The center rescues and rehabilitates injured and illegally traded animals. When possible, it releases slow lorises into the forested park, some with trackable collars so their reentry can be monitored. Center director Sonya Prosser says this slow loris was released in 2015, and "as far as we know, she is still out there."

NATIONAL GEOGRAPHIC
PHOTO ARK
JOEL SARTORE


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BACKUP BEES?

By Catherine Zuckerman

A honeybee queen, when all is right in her world, should live for two to three years. But in the United States, beekeepers have seen that life span drop by more than half over the past decade, and researchers are trying to determine why. It's one of many questions surrounding the mystery of honeybee mortality, a disturbing phenomenon that's linked to a mix of factors, including parasites, pesticides, and habitat loss.

Aside from making a delicious natural sweetener, honeybees—which are not native to the U.S.—also provide a crucial service to agriculture: pollination. From apples to almonds, many crops would suffer without honeybees. And while about 90 percent of beekeepers in this country are hobbyists, the majority of hives belong to large-scale, commercial operations, says North Carolina State University entomologist David Tarpy.

Colony collapse in general could be devastating to food production. So scientists are looking for alternatives. Most honeybees in the U.S. today are of Italian heritage and vulnerable to a pest called the varroa mite. But Russian bees are more resistant to it, and backyard beekeepers have had success with them. The problem, says Tarpy, is that Russian honeybees don't make as much honey as their Italian counterparts and "aren't as amenable" to the migratory nature of pollinating large-scale farms.

Another option, says wildlife biologist Sam Droege of the U.S. Geological Survey, is to embrace the thousands of North American wild bee species, which are excellent pollinators, rarely sting, and are typically the size of a grain of rice. The drawback for some people is that none of the wild bee species produce honey. But, says Droege, "we can always get honey from other countries."

The honeybee *Apis mellifera* (above) is native to Europe, the Middle East, and Africa. Now one of the most high-profile bees in North America, *A. mellifera* is in uncertain health.

PHOTO: USGS BEE INVENTORY AND MONITORING LABORATORY

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SO THAT'S WHY THE LONG FACE

By Jeremy Berlin

Let's face it: When it comes to expressions, a horse is no one-trick pony. Recent findings have revealed that our equine friends use 17 discrete facial movements to communicate. That's 10 fewer than humans—but one more than dogs and four more than chimpanzees.

Researchers at the University of Sussex discovered this by dissecting a horse head and identifying the musculature below its facial features. Then they watched behavioral footage—15 hours of video showing 86 male and female horses, from a variety of breeds, ranging in age from four weeks to 27 years.

The last step was to use a tool called EquiFACS (Equine Facial Action Coding System) to catalog the eye, lip, nostril, and chin movements they'd observed. The result: a gestural map that suggests evolutionary parallels among varied species.

Jennifer Wathan, the study's lead author, says the similarities between horse movements and human ones are striking. They include raising inner eyebrows ("puppy-dog eyes") to show fear, surprise, or sadness; pulling back lip corners (smiling) in greeting or submission; and opening eyes wide to indicate alarm.

Wathan says these findings can help us better understand interspecies relationships. Systems like EquiFACS "create a common language to objectively make comparisons across species—even those with totally different-shaped faces."

Her team's research, which is already helping veterinarians and trainers, could also connect facial expressions to emotional states. "We don't know much about the emotional lives of animals," she says. "What does a positive emotion look like? This tool could help us see it."

An Arabian horse looks around its stable in the United Arab Emirates. Horses are visual animals – they see better than cats and dogs – with communication skills that evolved to keep family groups together.

PHOTO: TIM FLACH

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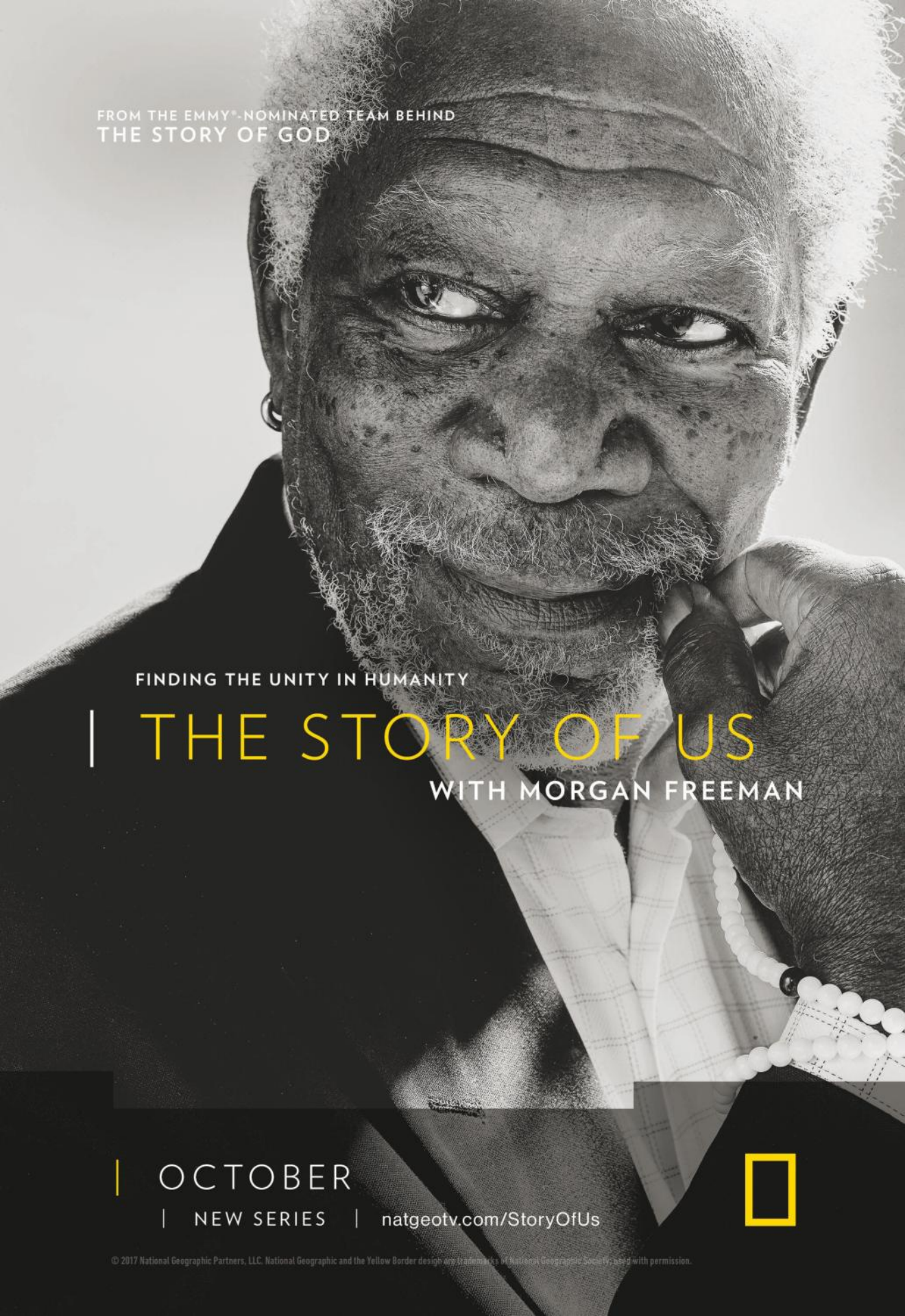


CELEBRITY STATUS

By Catherine Zuckerman

Of the roughly 18,000 new species discovered each year, a few have a certain star quality. In 2008, when an orange-haired, ornately patterned spider was found in Malaysia, it was named *Heteropoda davidbowie*. In 2010 a whale fossil made a splash when it was dubbed *Leviathan melvillei*. There's a rare Australian horsefly that goes by *Scaptia beyonceae* and a tree frog from Ecuador called *Hyloscirtus princecharlesi*.

Scientists have been formally naming species since the middle of the 18th century, when Swedish biologist Carl Linnaeus paved the taxonomic way. His binomial nomenclature system—still in use—identifies each distinct organism using a two-part name: its genus, or group, name, followed by its specific, or species, name. Think *Homo sapiens*.

Today animal species' names follow guidelines set by a governing body called the International Commission on Zoological Nomenclature. The person who finds a new species is free to name it, and some take inspiration from famous figures.

Attaching a celebrity's name could benefit an at-risk species or habitat by drawing attention to it. Naming can also be simply a science-nerdy form of flattery. German aracUologist Peter Jäger says he named his spider *H. davidbowie* for both purposes. "Of course," he says of the singer-songwriter, "I'm a big fan."

SPIDER ODDITY
David Bowie called his bandmates the Spiders From Mars – but the real spider called *Heteropoda davidbowie* (above) hails from Southeast Asia. The scientist who found the orange-haired species named it in 2008 to honor Bowie (who died in 2016) and his orange-haired alter ego, Ziggy Stardust.

ART: HANOCH PIVEN
PHOTO: MARIANNE BROUWER, NATURE IN STOCK

The early discoveries that drew National Geographic's attention occurred with no cameras present. Jane Goodall disliked being photographed but would come to accept it as a way to gain support for her work.

GETTY IMAGES

Becoming Jane

She was a novice scientist who became famous because of her groundbreaking studies of chimpanzees. Newly revealed images shed light on how she did it, the compromises she made, and the photographer she loved.

GETTING THE SHOT These frames are from reels of film outtakes that were found in storage in 2015. They were shot in the early 1960s at Gombe Stream Game Reserve, in what is now Tanzania, by cinematographer Hugo van Lawick. National Geographic assigned Hugo to document chimp behaviors

ALL FILM FOOTAGE BY HUGO VAN LAWICK

but also to film and photograph what they called “human interest” – Jane playing with the chimps and even washing her hair. Hugo and Jane disliked such frivolous scenes, but they went along with the requests, to keep the funding for Jane’s research flowing from the National Geographic Society.

THE SHOOTER AS SUBJECT

Hugo – here enjoying a cigar while hanging from a Gombe tree – was a perfectionist, much to Jane's frustration. He wouldn't photograph even remarkable chimp behavior if the light and exposure weren't right. Always innovating, Hugo scattered sand from the beach on the ground at Gombe's feeding station because it reflected light into the chimps' faces. Jane eventually got a Super 8mm camera so that she could film chimps at any moment, regardless of the lighting.

NATIONAL GEOGRAPHIC DOCUMENTARY FILMS

Directed by Brett Morgen with music by composer Philip Glass, the feature documentary *JANE* uses never before seen footage to tell Goodall's life story. National Geographic releases the film in select theaters this month.

BY TONY GERBER
PHOTOGRAPHS BY HUGO VAN LAWICK

'You may have heard my story before,'

Jane Goodall told her audience at a 2015 lecture. "But it's like a campfire tale—it gets better with each telling." Her story is instantly recognizable from the many times it's been written, broadcast, or otherwise sent into the world: *A young Englishwoman conducts chimpanzee research in Africa and winds up revolutionizing primate science.* But how did it happen? How did a woman with a passion for animals but no formal background in research navigate the male-dominated worlds of science and media to make enormous discoveries in her field, and become a world-famous face of the conservation movement? This is that story.

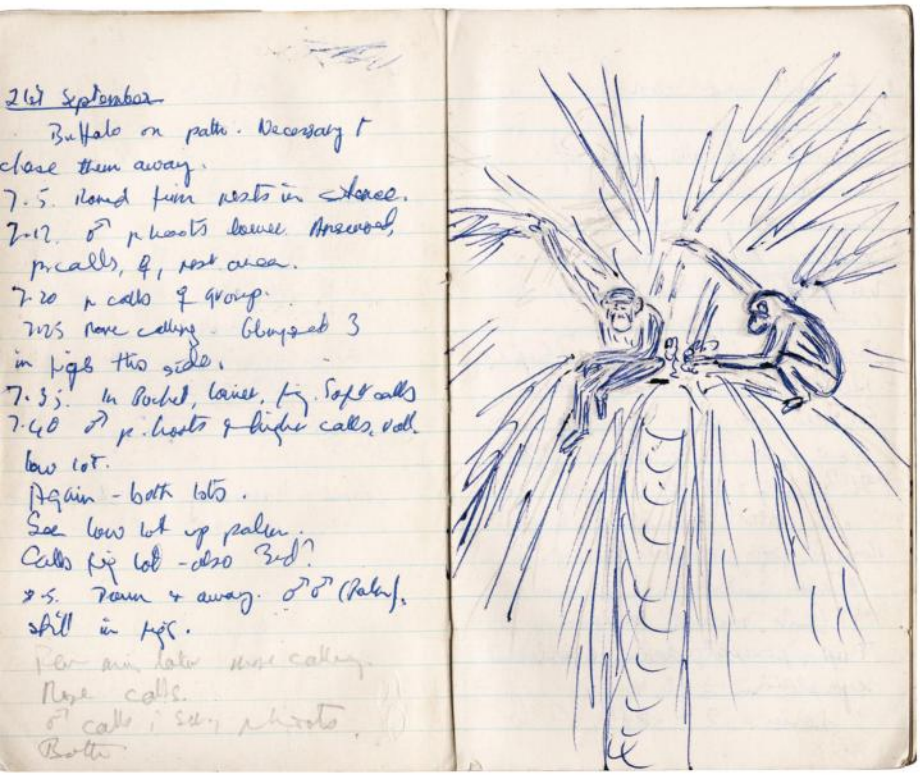
Jane became widely known because of a film, *Miss Goodall and the Wild Chimpanzees,* which came out in 1965 and was produced by National Geographic. She hasn't seen it in years. But now I'm playing it for her on a laptop at the West London home of a friend. The primatologist, 83 this year, studies her 28-year-old self.

"Think how fun it would be to be that age again," Jane says with a smile. The young Jane on the screen is hiking through the forest of Gombe Stream Game Reserve in what is now Tanzania. She's wearing high-top canvas sneakers and khaki shorts, and her blond hair is in the ponytail that became her signature. She appears to be doing field research—but in reality, Jane says, she was reenacting events from her first six months at Gombe so that photographer Hugo van Lawick could film them. Those months had been a remarkable period of solitude and discovery, a time before cameras were present. They've

NGM MAPS

REALITY TV

Once Jane and Hugo married, the focus of the human interest frame widened to include them both. This shot required a second camera to tell the story of the couple's filmmaking collaboration at Gombe. They became arguably the first reality TV couple.



NOTES AND OBSERVATIONS
At Gombe, Jane filled the field notebooks she carried every day with words and sketches. In the early days she typed up the notes by lamplight. The chimp she named David Greybeard (right) was the first to visit her in camp and allow her to touch him. In time David brought cohorts along, looking for bananas or cloth. The chimps had a penchant for dish towels and aprons, which they enjoyed sucking on. Here he explores the contents of a storage box.

been present in her life ever since.

National Geographic executives had specifically told Hugo which shots to get, Jane remembers: "They gave us a list: Jane in the boat, Jane with binoculars, Jane looking at a map." When *Miss Goodall and the Wild Chimpanzees* was broadcast on CBS on December 22, 1965, an estimated 25 million North American viewers tuned in—a huge audience, then and now.

The exposure brought Jane international acclaim and ignited what became a legendary career in primatology. In Jane, National Geographic found a telegenic researcher and storyteller with a film-ready setup: an attractive white woman doing scientific work in the African bush. It was especially poignant at a time when women typically were discouraged from pursuing careers in science.

Since then, Jane has completed a Ph.D. at Cambridge University, authored dozens of books, mentored new generations of scientists, promoted conservation in the developing world, and established several sanctuaries for chimps. Today the Jane Goodall Institute's Roots & Shoots program is in nearly a hundred countries, training young people to be conservation leaders. And Jane still travels about 300 days a year to lobby governments, visit schools, and give speeches.

Jane has been the subject of more than 40 films and has made countless appearances on television. Now she is the subject of a new National Geographic Documentary Films release about her life and work. The two-hour feature, *JANE,* draws from never before seen footage to offer a revealing portrait of the woman whose devotion to chimpanzees made her famous.

When Hugo first went to Gombe in 1962 to document Jane's discoveries, he shot thousands of still images and more than 65 hours of 16mm film footage. A fraction of the work made its way into the 1965 television special and *National Geographic* magazine. What the editors didn't use, the outtakes, went into film cans and boxes for storage and over time were forgotten. In 2015 they were found in an underground storage facility in rural Pennsylvania. These precious rolls of film held the promise of something rare: a new perspective on Jane. On film, every so often at

SKETCH: COURTESY JANE GOODALL
PHOTO: JANE GOODALL INSTITUTE

the end of a take, she drops her serious persona and glances directly at the lens—toward Hugo, her director. In these few instances, we see the stirrings of love for the man behind the camera.

Taken together, this trove of material provides an intimate view of Jane at a pivotal time: When a young woman who had known Africa only from Tarzan and Dr. Dolittle books was dropped into her fantasy, and when a novice scientist's discoveries debunked long-held beliefs about humans' closest living relatives.

At Gombe, Jane withstood all manner of natural threats: malaria, parasites, snakes, storms. But in her dealings with the wider world, the challenges often required shrewd strategy and delicate diplomacy. Early in her career, Jane had to contend with a primarily male science establishment that didn't take her seriously; with media executives whose support hinged on her willingness to be scripted and glamorized; with men who said they'd be her partner or patron but also sought control, concessions, or relationships that she did not want.

Through it all, Jane's philosophy seemed the same: She would endure slights, accommodate demands, tolerate fools, make sacrifices—if it served to sustain her work.

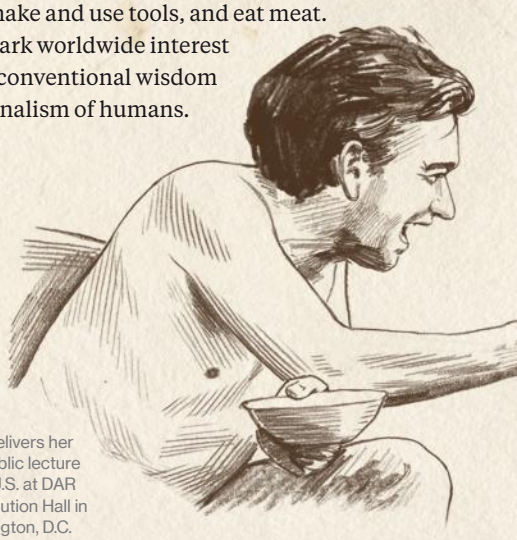
FROM HER CHILDHOOD in England, Valerie Jane Morris-Goodall professed a deep love of animals and a desire to work with them in Africa. Her family lacked the means to send her to college, so Jane went to secretarial school. She worked at Oxford and then for a documentary film company in London. In the summer of 1956 she returned home, where she waited tables to save for an ocean passage to Kenya.

In Nairobi she boldly asked for an appointment with paleoanthropologist Louis S. B. Leakey, whose interest in great apes grew from his pioneering research into human origins. Leakey hired Jane on the spot to do secretarial work and saw in her the makings of a scientist. He arranged for her to study primates while he raised funds so she could conduct chimpanzee field research in Tanzania.

And within months of their first meeting, he told Jane he was in love with her.

THE MAKING OF Jane Goodall.

In 1957 a young Jane Goodall travels to Africa and meets the eminent paleontologist Louis Leakey. Three years later he assigns her to study chimpanzee behavior in Tanzania, where she discovers that chimpanzees make and use tools, and eat meat. Her findings spark worldwide interest and upend the conventional wisdom on the exceptionalism of humans.



At age 23 Jane travels to Kenya to visit a friend's family. An animal lover, she is advised to seek out Louis Leakey.

Jane begins work in Gombe Stream Game Reserve, where she finds that chimpanzees make and use tools, and eat meat.

When told of Jane's discovery, Leakey responds via telegram: "Now we must redefine tool, redefine man, or accept chimpanzees as human."

1957 1958 1959 1960 1961 1962 1963 1964 1965 1966

Jane enters Cambridge University as a Ph.D. candidate, one of the few people ever to be admitted without a college degree.

Jane delivers her first public lecture in the U.S. at DAR Constitution Hall in Washington, D.C.

Jane and Hugo wed.

Jane establishes the Gombe Stream Research Center with funding from National Geographic.

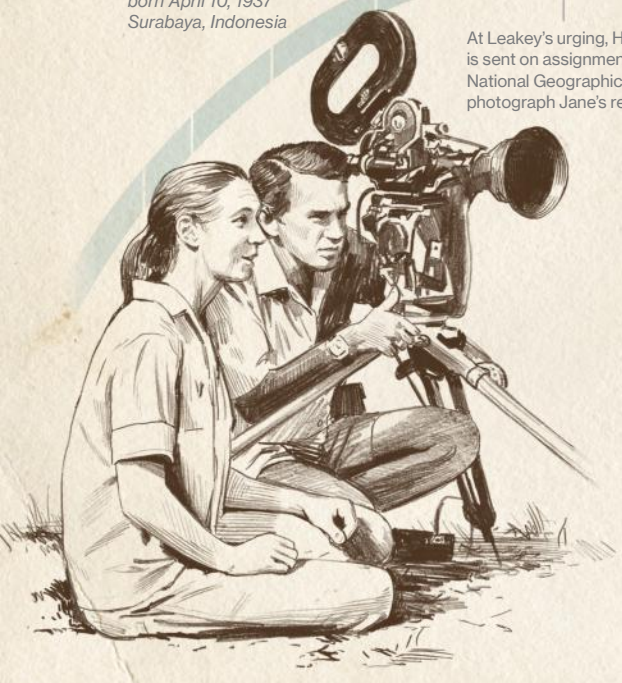
Jane meets Dian Fossey, another Leakey protégé.

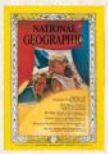
Jane earns a Ph.D. in ethology.

Valerie Jane Morris-Goodall
born April 3, 1934
London, England

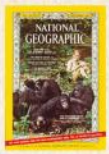
Hugo Arndt Rodolf Baron van Lawick
born April 10, 1937
Surabaya, Indonesia

At Leakey's urging, Hugo is sent on assignment by National Geographic to photograph Jane's research.





'My Life Among Wild Chimpanzees'
Article by Jane
Photographs by Hugo



'New Discoveries Among Africa's Chimpanzees'
Article by Jane
Photographs by Hugo

Miss Goodall and the Wild Chimpanzees
Movie by Jane and Hugo

The fruits of teamwork

At first reluctant to have a photographer document her research, Jane partners with Hugo in work, and later in marriage. She makes significant discoveries about animal behavior.

I feel it is important to draw attention to the fact that the work which Jane Goodall has done, with research grants from the Society, has been so important as to necessitate a complete review of scientific thought about how to define man himself.

L.S.B. Leakey

A chimpanzee named Flo nibbles termites from a blade of grass.

Hugo and Jane feeding Grub in the Serengeti, 1968

1967

Hugo Eric Louis, affectionately known as Grub, is born in Nairobi, Kenya.

My Friends, the Wild Chimpanzees
Book by Jane
Photographs by Hugo

'Tool-Using Bird: Egyptian Vulture Opens Ostrich Eggs'
Article by Jane and Hugo
Photographs by Hugo

1968

Gombe Stream Game Reserve becomes Gombe National Park.

1969

1970

Innocent Killers
Book by Jane and Hugo
Photographs by Hugo

Grub the Bush Baby
Book by Jane
Photographs by Hugo

Jane joins the faculty at Stanford University and starts the Stanford Outdoor Primate Facility.

1971

In the Shadow of Man
Book by Jane
Photographs by Hugo

1972

Gombe Research Center becomes independent of National Geographic.

Louis Leakey dies.

Jane and Hugo become estranged.

1973

The Wild Dogs of Africa
Movie by Jane and Hugo

1974

Jane and Hugo divorce.

Solo: The Story of an African Wild Dog
Book by Hugo
Editing by Jane
Photographs by Hugo

1975

Four researchers from Gombe are kidnapped by rebels from Zaire (modern Democratic Republic of the Congo), then freed 40 days later.

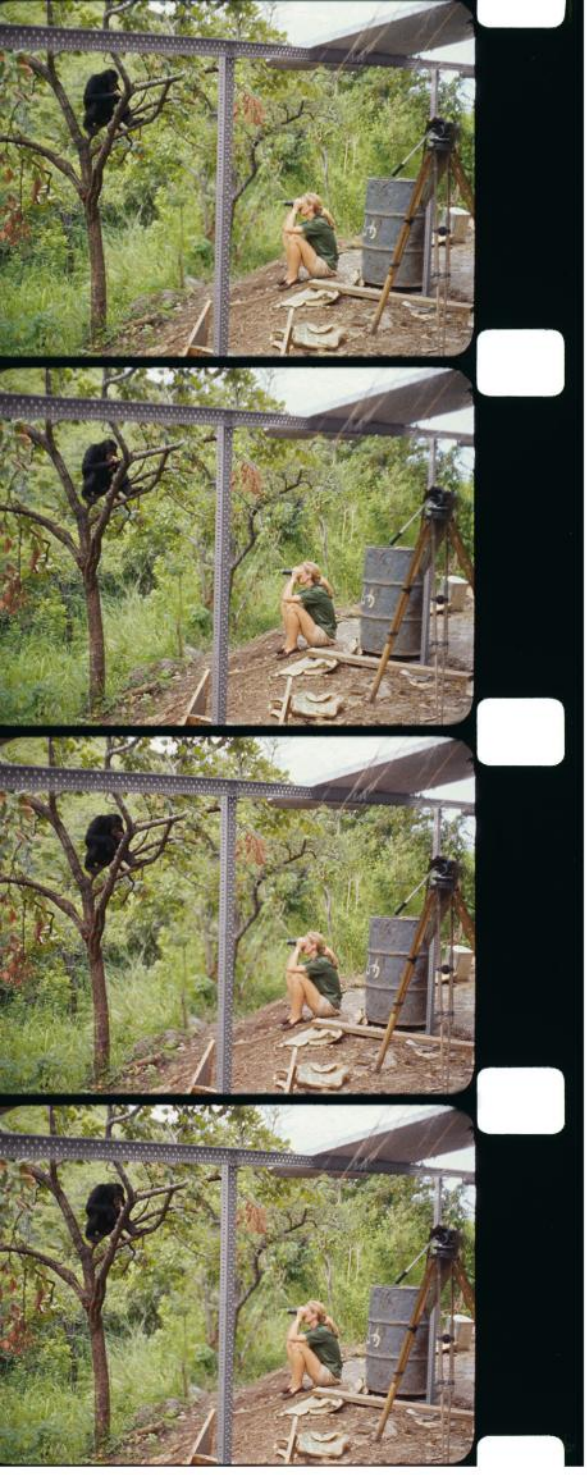
1976

The Jane Goodall Institute, devoted to wildlife conservation, is established. Its work continues today.

1977

Hugo dies on June 2, 2002 Dar es Salaam, Tanzania

JASON TREAT, NGM STAFF; MEG ROOSEVELT
ART: JOE MCKENDRY
SOURCES: JANE GOODALL INSTITUTE; NATIONAL GEOGRAPHIC SOCIETY



A FEEDING STRATEGY
Jane sits on the concrete foundation of the new feeding station she and Hugo built, up the hill from their lakefront camp. They first put the feeding station near camp, to draw chimps to observe and film. After the chimps' demand for bananas became aggressive, they moved the site farther away.

Jane wrote to others that she was "horrified" by the overture from Leakey, who was 30 years her senior and married. For months after Jane told him firmly that she'd never return his feelings, Leakey still sent her love letters.

In an interview years later with Virginia Morell, author of a book on the Leakey family, Jane said that "what I was most afraid of was what my rejection of him might mean for my study of the chimpanzees." But Leakey never withdrew his support—and by the summer of 1960 Jane was setting up camp in the Gombe Stream Reserve near the shores of Lake Tanganyika, with enough funding for six months of fieldwork. Because government officials wouldn't allow a lone female to live in the reserve, Vanne Morris-Goodall came along as her daughter's chaperone.

From the start Jane followed her instincts for conducting research. Not knowing that the established scientific practice was to use numbers to identify animals under study, she recorded observations of the chimps by names she concocted: Fifi, Flo, Mr. McGregor, David Greybeard. She wrote about the chimps as individuals with distinct traits and personalities—for example, when a female she called Mrs. Maggs was preparing a treetop nest for the night, Jane wrote that the chimp had "tested the branches exactly the way a person tests the springs of a hotel bed."

She spent most waking hours locating the animals through her binoculars, then trying to draw gradually closer so they'd get used to her presence as she sat jotting notes. But with one month left in the study grant, she hadn't made the kind of significant discovery she felt would justify Leakey's faith in her.

As her study was approaching its end, Jane made three discoveries that would not only make Leakey proud but would also turn established science on its head.

In her first discovery, she observed a chimp gnawing on the carcass of a small animal, which belied the prevailing belief that apes didn't eat meat. The chimp was memorable for his prominent gray goatee, and she would name him David Greybeard. He in turn would open the door for her

to the hidden world of Gombe's chimpanzees.

Within two weeks Jane observed David Greybeard again, but this time what she witnessed was truly game-changing. Squatting by a termite mound, he picked a blade of grass and poked it into a tunnel. When he pulled it out, it was covered with termites, which he slurped down. In another instance, Jane saw him pick a twig and strip it of leaves before using it to fish for termites. David Greybeard had exhibited tool use and toolmaking—two things that previously only humans were believed capable of.

When Jane cabled the news to Louis Leakey, he sent this response:

> NOW WE MUST REDEFINE TOOL STOP
> REDEFINE MAN STOP
> OR ACCEPT CHIMPANZEES AS HUMAN

In the wake of these discoveries, National Geographic gave Jane a grant to continue her work at Gombe.

AS JANE BEGAN to write up and publish her field research, she met with skepticism from the scientific community. After all, she had no science training—no degree other than a secretarial certificate affirming that she could touch-type.

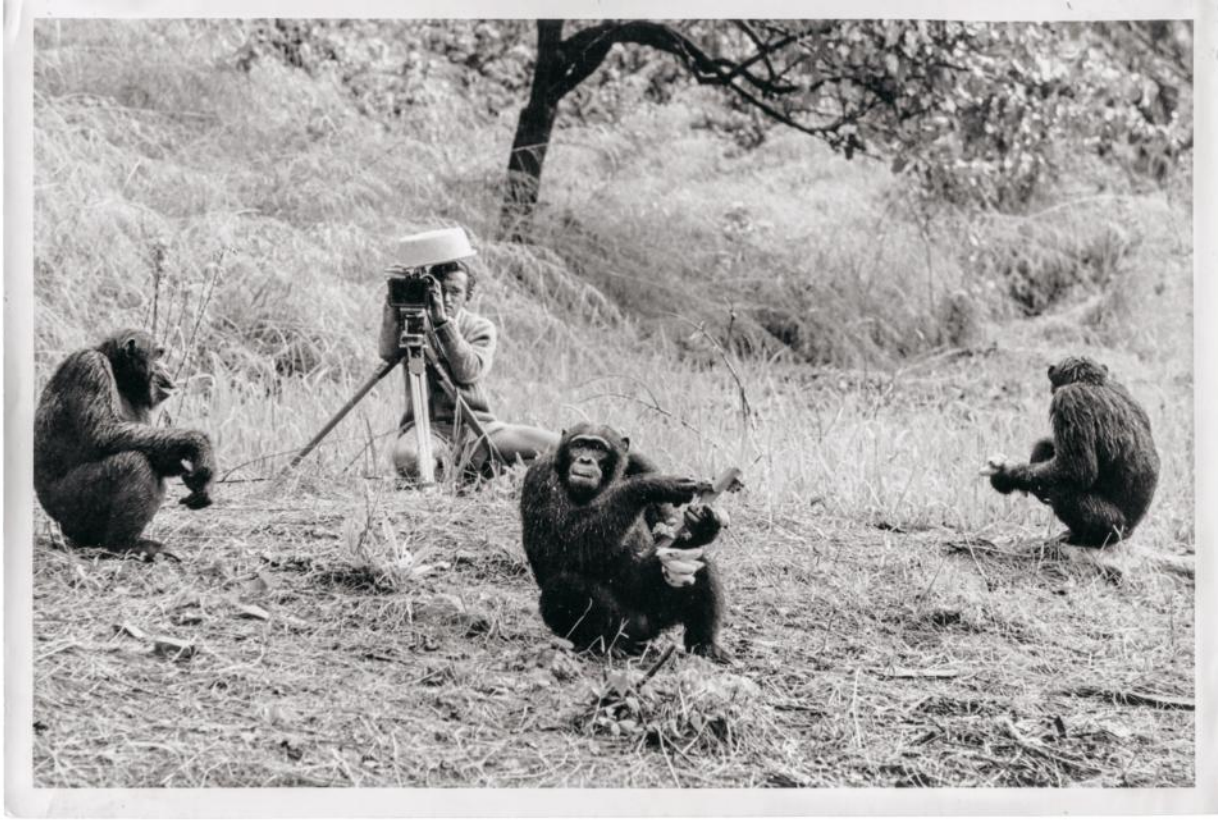
In the spring of 1962, Jane gave a presentation at the Zoological Society of London's primate symposium and impressed many in attendance, including zoologist and author Desmond Morris. But she also faced derision. A society officer delivered a thinly veiled critique of her work as "anecdote and … speculation" that made no "real contribution to science." An Associated Press report began with this: "A willowy blonde with more time for monkeys than men told today how she spent 15 months in the jungle to study the habits of the apes."

A photographic record of Jane's discoveries would put them beyond dispute. But Jane rebuffed National Geographic's request to send a photographer, saying a stranger might disrupt the relationship she was building with the chimps. After spending months getting close enough to even be in camera range, "I want to

EVERYONE'S A CRITIC
Jane shows a photo of an adult chimp to infant Flint. Before Hugo built a darkroom at Gombe, he had to ship exposed film to Washington, D.C., to be developed. It would be weeks before he'd receive feedback on the photos' exposure or subject matter.

Flint was the first infant born at Gombe after Jane arrived. With him she had a great opportunity to study chimp development – and to have physical contact, which is no longer deemed appropriate with chimps in the wild.

HUGO VAN LAWICK, NATIONAL GEOGRAPHIC CREATIVE



do my own photos—or have a jolly good try," she wrote in a letter home.

National Geographic shipped a camera and several rolls of film to Africa with detailed instructions on how to use them. Jane made a valiant effort. But her dark-furred subjects tended to hide in the shadows, and the photos she submitted weren't up to the magazine editors' standards. Again, editors pressed to send a Geographic photographer, and again Jane held them off: Her younger sister, Judy, had photography experience, and the two looked and sounded enough alike that the chimps might not be upset by the sister's presence.

Louis Leakey underwrote Judy's trip to Gombe, covering the expense by selling rights to print the first pictures to a British weekly. Ultimately the *Geographic*'s editors found her photos unsatisfactory too.

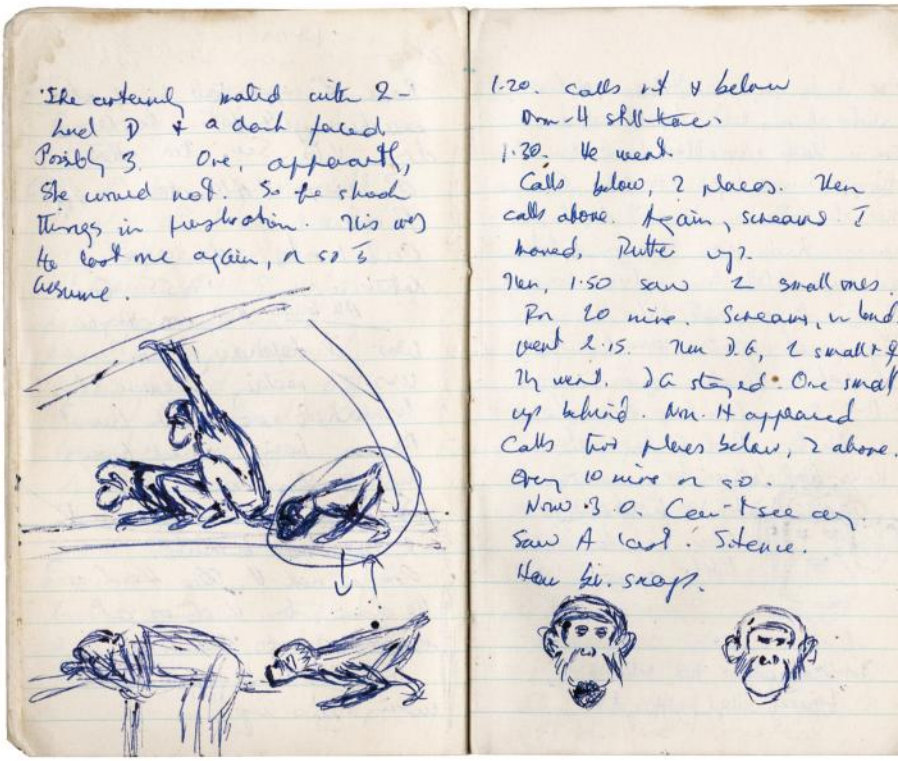
National Geographic magazine wanted Jane to write an article about her work—but it couldn't go forward without "good pictures of the animals," an editor warned. Jane understood that if she couldn't get her work covered in the magazine, her funding from the National Geographic Society could be in jeopardy.

Leakey had helped Jane get into a Ph.D. program at Cambridge University—she was one of the few individuals without an undergraduate degree to ever be admitted—and he asked National Geographic to support Jane as she wrote up her Gombe research and worked on her dissertation.

When the Geographic turned down the request, saying, "this lady ... is unqualified in the sense that she holds no degree of any university," an outraged Leakey fired off a memo listing her accomplishments. National Geographic officials gave Jane the requested grant, but as part of the deal, she agreed to welcome a professional photographer to Gombe. On Leakey's recommendation, National Geographic hired Hugo van Lawick for the job.

The opportunity to work at Gombe with Jane would be a huge break for the 25-year-old Dutchman, who had some experience in natural history filmmaking. Jane wrote to a friend that she actually looked forward to his arrival because she'd been told that Hugo was "a first-class photographer, wonderful with animals—well, it's just too good to be true."

When I interviewed Jane in 2015, she insisted that "Louis was definitely matchmaking when he sent Hugo. There's no question, and he admitted



HUGO'S AUDITION
Jane captured chimp images with pen and paper, Hugo used film. At National Geographic in Washington for his job interview, Hugo was handed a camera and told to shoot some frames around town as a tryout. "I shoot animals, not people," he responded. When the *Geographic* editors persisted, Hugo made his way to the National Zoo. Editors particularly liked a photo he made there of a pelican; they hired him for the job at Gombe.

it." Jane believes that Leakey's enduring love for her was selfless in the end.

Hugo reached Gombe in August 1962. He smoked heavily; Jane detested the habit. Otherwise they were well matched, both ardent observers of wildlife and devoted to their work. In a letter to a friend, Jane wrote, "We are a very happy family. Hugo is charming and we get on very well."

As Jane and Hugo documented the chimps' behavior, neither felt it worthwhile to focus on Jane as well. But National Geographic executives were increasingly eager to turn the camera on her.

"I know you won't forget to get some pictures of straight camp life—cooking, the writing of reports into the night by lamp light, bathing, hair washing and the like," assistant illustrations editor Robert Gilka wrote in a letter to Hugo in the fall of 1962. "I bring up the hair washing bit because there came out of Jane's last trip to the chimp reserve just such a picture, but it was ... so underexposed that it would not reproduce." Good shots of Jane washing her hair in a stream, Gilka stressed, "would be a big help."

IN THE LONDON HOME where *Miss Goodall and the Wild Chimpanzees* is still playing on the laptop, we've come to the hair-washing scene. Even today, it doesn't sit well with Jane.

"I was angry they filmed this," she says.

Why? I ask.

"I don't see why people should see me washing my hair. I couldn't see why it was interesting."

Hugo's work pleased *National Geographic*'s editors. He was checking off the boxes: capturing photographic proof of the chimps' toolmaking and use, nestbuilding, social hierarchies—and dutifully taking the human interest shots of Jane that Gilka had requested.

His photographs appeared with Jane's words in *National Geographic* magazine's August 1963 cover story, "My Life Among Wild Chimpanzees: A courageous young British scientist lives among these great apes in Tanganyika and learns hitherto unknown details of their behavior."

The issue was a resounding success. National Geographic Society President Melville Grosvenor paid Jane and Hugo bonuses and called the article "magnificent." On its first page, a short text introducing Jane captured the duality of the public image being crafted for her. In one paragraph, she was called "a modern scientific zoologist"—and in the next, "a charming young Englishwoman."

PHOTO: JANE GOODALL INSTITUTE
SKETCH: COURTESY JANE GOODALL

ROUGHING IT
In her book *My Friends, the Wild Chimpanzees,* Jane recalled her first day at Gombe, helping to pitch tents that would serve as her home for years to come. "I was well aware of some of the many difficulties facing me," she wrote. "Equally, I knew the day was one of the happiest of my life."

As Jane and Hugo expanded the research station at Gombe, they also developed ideas for new films, but National Geographic wanted to keep the spotlight on Jane in films being made for television and the lecture circuit. The requests were increasingly specific, as in this letter to Hugo from Joanne Hess of the National Geographic Society's lecture branch:

"It will be most important and helpful to have several shots of Jane, which you will have to pose, showing her looking through binoculars, laughing at chimps, staring up at chimps in trees, staring into distance at chimps, and writing notes in her book, etc.," Hess wrote. "I mean you should take about 200 feet of close-ups of Jane 'pretending' to do these things, so that we can cut pictures of her into the film."

The pressures to pose rankled Jane, but she handled it diplomatically. In a letter to Melvin Payne, whose National Geographic committee oversaw her funding, Jane wrote, "Certainly I understand that it is necessary to build up a story around 'Jane Goodall' and we have cooperated with Joanne as much as we possibly could."

But when Hess came to Gombe to oversee some filming, Jane allowed herself a private act of rebellion. "We are already collecting large numbers of evil looking spiders and centipedes to lay around casually in her tent, in an endeavor to shorten her visit," Jane wrote to her mother.

When I interviewed Jane years later, during a 2015 visit to Gombe, she could look back on the celebrity treatment more philosophically:

GOODALL: There's this glamorous young girl out in the jungle with potentially dangerous animals. People like romanticizing, and people were looking at me as though I was that myth that they had created in their mind. And the Geographic helped create it too.

GERBER: A lot of people would resist that and fight back and say, That's not me.

GOODALL: There was nothing I could do about it because as far as they knew, it was me. And there was no way I could be portrayed differently. It wasn't inaccurate. It's just that people take the facts and weave stories around them.

GERBER: But at some point you embraced it? You embellished it? You made it better?

GOODALL: Well, at some point I realized that if people were going to think this way, then they would listen to me, which is true. And this would help to conserve chimps and do all the other things I need to do.

AS 1963 ENDED, Jane confided to friends that she and Hugo were "very much in love." During Christmas holidays at her family home in Bournemouth, on England's southern coast, she received a telegram: "WILL YOU MARRY ME STOP HUGO." She replied yes. They set March 28 as the wedding date, one month after what would be another red-letter day for Jane: her first major public lecture in the United States.

Jane was a little nervous about being on stage at the 3,700-seat DAR Constitution Hall in Washington, but the members of National Geographic's lecture committee seemed more nervous. She was to give her remarks against the backdrop of a film made from Hugo's Gombe footage. As the February 28 event neared, the committee asked for a draft of her speech. Jane hadn't written one.

Seeking assurance that the lecture would go well, Joanne Hess and her team asked Jane to join them in the editing room, to practice her remarks as the film played. When I interviewed her at Gombe in 2015, she recalled the scene:

"The Geographic naturally wanted to hear what it would be like," she recalled. "Well, it's very hard for me to practice something ahead; it comes out to the audience. I didn't know that then. I just knew that with three people listening to me in that cutting room, this isn't a lecture! Apparently they were all whispering to each other, 'Shall we cancel it? It's going to be a disaster! Can we really have the Geographic associated with this young gal? She doesn't seem to know what she's going to say.' I had every idea what I was going to say, but I wasn't going to give a whole speech to three people in a cutting room."

In her speech and film presentation at Constitution Hall, Jane reported on her scientific discoveries, which she called "results beyond my wildest dreams." She evoked scenes of Gombe's

A NOVEL APPROACH
Jane's study had no precedent. Here she shows the juvenile Fifi a toy chimp. As much out of novelty as scientific research, Jane shared things with the chimps they never would've seen in the wild: from Hugo's shaving mirrors to copies of *National Geographic.*

beauty and tranquility. And as she would throughout her career, she described chimps by their personalities and the names she'd given them. She called Fifi "agile and acrobatic" and described Fifi's older brother Figan as an adolescent who "feels he's a little bit superior." To a baby who was "just beginning to find her feet," Jane had impishly given the name Gilka, after the *National Geographic* editor.

And in describing the need to protect the chimps and prevent them from being shot or sold to circuses, Jane referred to David Greybeard, the trusting chimp who had opened the door to some of her most important discoveries.

"David Greybeard ... has put his complete trust in man," she told the audience. "Shall we fail him? Surely it's up to us to do something to ensure that at least some of these fantastic, almost human creatures continue to live undisturbed in their natural habitat."

Her presentation was a triumph, and a milestone in her emergence as a public figure—a status she didn't start out seeking but was learning to manage to her advantage. It caught the attention of a National Geographic executive who was launching a television specials division. A good deal of the Gombe footage ended up in one of the division's first prime-time broadcasts: *Miss Goodall and the Wild Chimpanzees,* with narration by Hollywood luminary Orson Welles.

When Hugo and Jane first screened the finished film, they complained of its many inaccuracies. They found the Welles narration patently unscientific—and at Jane's insistence, the script was partially rewritten.

To this day, as she watches the film on the laptop, Jane points out flaws. That leopard wasn't photographed by Hugo, it was stock footage. That scene isn't in Gombe, it's somewhere in the Serengeti. And when Welles begins a sentence with "After two months' search in vain," Jane cuts him off: "It wasn't true that I didn't see any chimps for two months. That's an absolute lie."

The flaws seemed to matter only to Jane and Hugo; the film was a commercial success. The two hoped they might do another film project and have more creative control, but Geographic officials had other ideas. They wanted to do more with Jane and Gombe, but not necessarily with Hugo. Jane was their star; Hugo, an accessory.

In the years after the filming at Gombe, Jane and Hugo took different paths. In 1967 Hugo and Jane welcomed a son, Hugo Eric Louis van Lawick, known by his nickname, Grub.

With Jane's work anchored in Gombe and Hugo's filmmaking passion in the Serengeti, nearly 400 miles away, the two grew apart. In 1974 Jane and Hugo divorced. In 1975 she married Derek Bryceson, a Tanzanian government official.

By the time Grub was eight, he was living with his grandmother and attending school in Bournemouth. Derek and Jane had been married for only five years when he died of cancer in 1980. After a career spanning four decades, Hugo died of emphysema in 2002.

WHEN I INTERVIEWED Jane in Gombe, it had been 55 years since she'd climbed out of a skiff and onto a pebble beach there for the first time. In her mind's eye she can see things as they were then, from that beach up to the high ridge known as the peak: "It's like another life, so long ago."

She can even watch herself pretending, and today recount it with a smile.

In the film footage, Jane sees her 28-year-old self seated on the peak. It's magic hour, nightfall. Hugo's exposure is perfect. On screen, Jane pulls a blanket around her shoulders. She raises a tin cup to her mouth and sips.

Now it's Jane who's the narrator.

"That cup is empty, I swear," she says. "There's nothing inside it." □

"A PECULIAR WHITE APE"

That's how Jane thought the chimps regarded her: As one of them, just different. Here Flo's daughter Fifi looks up Jane's shirt. "I became totally absorbed into this forest existence," Jane wrote later.

GETTY IMAGES

Tony Gerber is an award-winning filmmaker and a co-founder of Market Road Films, a production company based in New York. For National Geographic, he has written and directed a dozen documentaries.

Dubai's Audacious

Goal

A decade ago the emirate capital had one of the largest ecological footprints of any city in the world. By 2050 it wants to have the smallest. Can it get there?

Dubai touts its superlatives. At the Green Planet, visitors walk around an 82-foot artificial tree – claimed to be the world's largest – in a rain forest habitat that shelters 3,000 species of tropical plants and animals. The biodome is one of the city's growing number of "green buildings," which meet a high standard for energy efficiency.

Preceding pages: Tourists flock to Burj Khalifa, the world's tallest skyscraper at 2,717 feet, for this bird's-eye view. Some urban plans call for scaling down – the opera house (bottom center) is part of a new ground-level district designed to encourage strolling and to link to mass transit in the car-centric city.

BY ROBERT KUNZIG
PHOTOGRAPHS BY LUCA LOCATELLI

To plunge headlong into the audacity of Dubai—the sprawling efflorescence of concrete, glass, and steel that has sprung up over the past three decades on the scorched sands of Arabia—you could start by going skiing. From outside the Mall of the Emirates, the slope looks like a silver spaceship impaled in the ground floor. Inside you can window-shop at Prada, Dior, and Alexander McQueen before pushing through the glass doors of Ski Dubai. Passing a mural of the Alps, you zip up your parka, pull on your gloves—and marvel at what air-conditioning can do.

The souvenir T-shirt I bought bears a cartoon of a Celsius thermometer. "I went from +50 to -8," it announces. It didn't feel quite that cold on the slope, but the temperature outside in Dubai can get close to 50 (122°F) in summer. The humidity is stifling then because of the proximity of the sea. Yet it rarely rains; Dubai gets less than four inches a year. There are no permanent rivers. There is next to no soil suitable for growing crops.

What kind of human settlement makes sense in such a place? For centuries Dubai was a fishing village and trading port, small and poor. Then oil and a wild real estate boom transformed it into a city that sports a skyline of architectural wonders and the world's third busiest airport. "From the point of view of sustainability, you probably wouldn't have done it here," says Janus Rostock, a prominent architect transplanted from Copenhagen.

And yet a sustainable city is precisely what Dubai's government now says it aims to create.

Sustainable? Dubai? When camels fly, you might say. The boom years made the city a poster child for the excess that results when cheap energy meets environmental indifference. Indoor skiing is just a symbol: Dubai burns far more fossil fuel to air-condition its towers of glass. To keep the taps running in all those buildings, it essentially boils hundreds of Olympic pools' worth of seawater every day. And to create more beachfront for more luxury hotels and villas, it has buried coral reefs under immense artificial islands.

In 2006 the World Wildlife Fund (WWF) declared the United Arab Emirates the country with the largest ecological footprint per capita, largely because of its carbon emissions. The shoe certainly fit Dubai, the most conspicuous consumer among the nation's seven emirates. In the decade

This article is part of our Urban Expeditions series, an initiative made possible by a grant from United Technologies to the National Geographic Society.

A feat of air-conditioning, Ski Dubai is the Middle East's first indoor ski park, where Emiratis typically learn the sport on one of its five runs before heading to alpine resorts abroad. A new record-shattering slope is coming, part of a building boom spurred by Expo 2020 — a six-month exhibition expected to draw 25 million visitors.

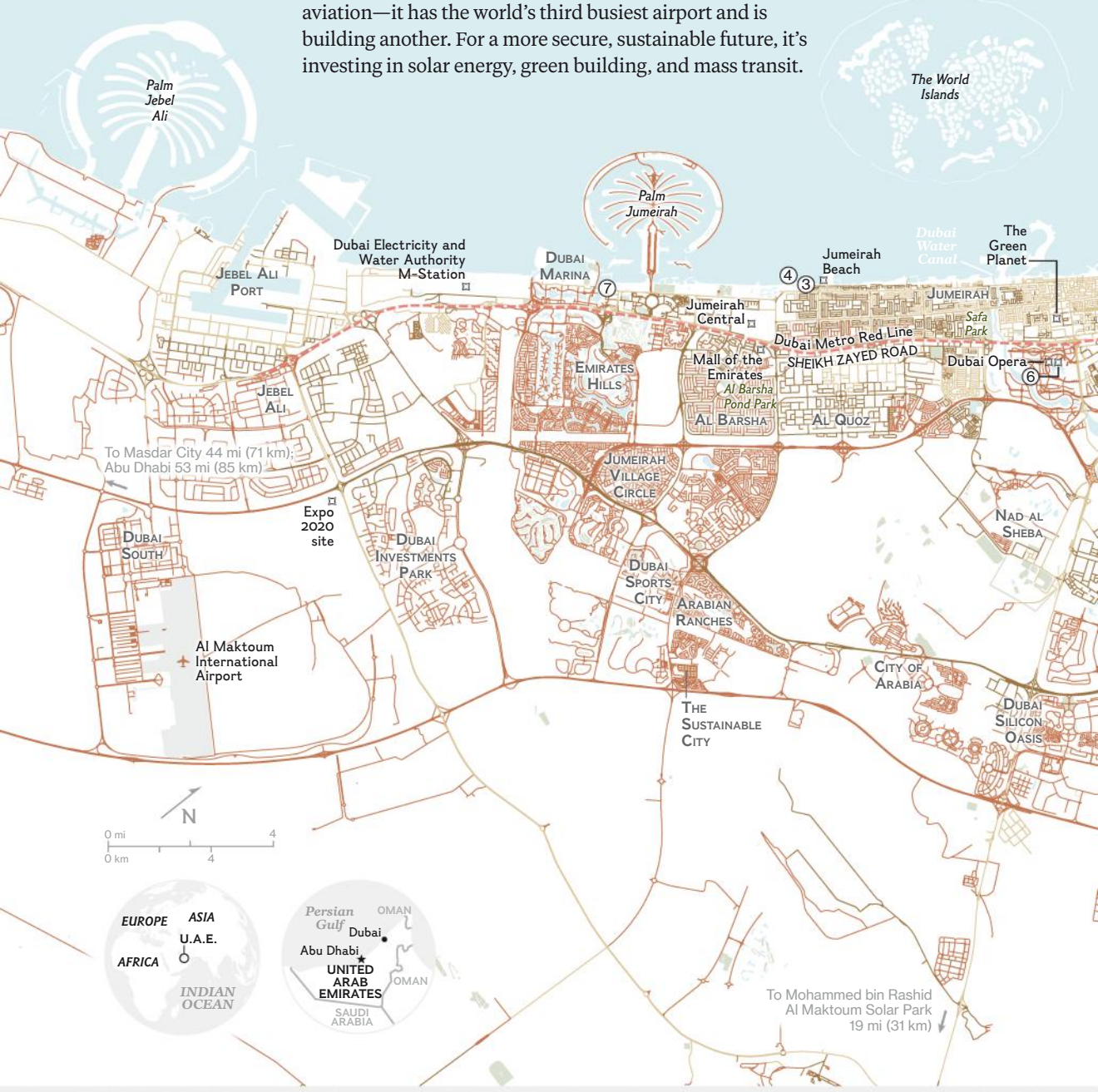
since, the city's population has doubled to more than 2.8 million. And yet something else has happened since 2006: Dubai has started to change.

Gleaming driverless metro trains now run alongside Sheikh Zayed Road, carrying about as many people as the cars on that clogged 12-lane artery—and often faster. A new housing development called the Sustainable City recycles its water and waste and produces more energy than it consumes. Out in the desert, Dubai is building a giant solar-power plant that will soon be producing some of the cheapest and cleanest electricity on Earth. "The leadership has recognized that the growth of the economy is not sustainable without taking action on emissions," says Tanzeed Alam, climate and energy director for the Emirates Wildlife Society, WWF's local partner.

In Dubai the "leadership" is His Highness Sheikh Mohammed bin Rashid Al Maktoum, the 68-year-old hereditary emir, aka the Ruler. Sheikh Mohammed took over in 2006. He has decreed that his city will get 75 percent of its energy from clean sources by 2050. He wants it to have the smallest carbon footprint in the world. Many people I met on a recent visit, including Rostock and Alam, believe the city might actually pull

Shifting Sands

In a single generation Dubai exploded from a humble settlement with modest oil reserves to a sprawling, car-centric metropolis fueled by tourism, real estate, and aviation—it has the world's third busiest airport and is building another. For a more secure, sustainable future, it's investing in solar energy, green building, and mass transit.



BUILDING AN ICONIC SKYLINE
A hub of daring architecture, Dubai is set to host a world's fair, Expo 2020, which spurred its latest construction boom.

1787
Al Fahidi Fort
The city's oldest building

1979
Sheikh Rashid Tower
Dubai's first skyscraper

1997
Jumeirah Beach Hotel
The famed design mimics a breaking wave.

1999
Burj Al Arab
The landmark hotel is sail shaped.

COASTAL EXPANSION

Completion of the man-made Palm Islands – Palm Jumeirah, Palm Jebel Ali, and Deira – could increase Dubai's coastline by more than 300 miles. The World Islands project has stalled.

URBAN EXPANSION

Pre-1985

Oil begins to flow in the 1960s, and with it come electricity, paved roads, an airport, and even the Middle East's tallest building.

1985-1999

Dubai's first iconic buildings go up, and its ecological footprint soars as the city's population, territory, and traffic grow.

2000-2016

Despite a pause during the 2008-09 crisis, the property boom continues as foreigners are allowed to own and invest.

DAMIEN SAUNDER, DAISY CHUNG, AND IRENE BERMAN-VAPORIS, NGM STAFF; ED MERRITT. SOURCE: © OPENSTREETMAP CONTRIBUTORS, AVAILABLE UNDER OPEN DATABASE LICENSE: *OPENSTREETMAP.ORG/COPYRIGHT*

*IN-PROGRESS AND FUTURE PROJECTS WITH PROPOSED COMPLETION DATES AS OF JULY 2017

2000
Emirates Towers

The larger tower was the tallest in the Middle East when first built.

⑤

2010
Burj Khalifa

The world's tallest structure at 2,717 ft (828 m)

⑥

2013
Cayan Tower

A skyscraper built with a 90-degree twist

⑦

2017*
Dubai Frame

The structure frames views of old and new Dubai.

⑧

2020*
Dynamic Tower

Each floor will separately rotate on this shape-shifting tower.

Location yet to be determined

On the compact streets of the Sustainable City (center), its 500 villas shade each other, reducing air-conditioning needs – a contrast to the neighboring larger lanes, lots, and homes. Each villa has solar panels; the "net zero energy" community generates all its own power and grows produce in 11 domed greenhouses.

that off. And if it can happen here, they say, it can happen anywhere.

SHEIKH MOHAMMED GREW UP in a house lit by oil lamps, where water from the village well was delivered by donkey cart. The house belonged to his grandfather, the emir; the Al Maktoum family has ruled Dubai since 1833. The house still stands near the mouth of Dubai Creek, a natural harbor that is the reason the city exists at all. Sheikh Mohammed's father, Sheikh Rashid bin Saeed Al Maktoum, had grown up in the same house and as a young man had endured years when people in Dubai starved; the Great Depression and the invention of cultured pearls had destroyed the market for pearl diving, the town's main enterprise.

It was Sheikh Rashid who began to modernize Dubai after taking over as ruler in 1958 and especially after oil started to flow in the late 1960s. He quickly brought in electricity, running water, and paved roads. He built schools, an airport, and, in 1979, the 39-story World Trade Centre (now Sheikh Rashid Tower), at the time the tallest building in the Middle East. "It was built in the middle of nowhere, on the edge of the city," says Neil Walmsley, a Dubai-based British engineer and urban planner with the consulting firm Arup. "The city responded by growing towards it"—and then well past it.

The pearl business hadn't lasted forever, and Sheikh Rashid knew the oil wouldn't either. Dubai holds just a fraction of the U.A.E.'s oil—Abu Dhabi has the lion's share. So while Dubai was not a center of world trade in 1979, when Sheikh Rashid built the Trade Centre, he set about making it one. That same year he opened a second and larger port at Jebel Ali, 25 miles from the Creek, as it's known.

His son Mohammed filled the empty space between the two, turning Dubai into a hub not only of trade and finance but also, improbably, of tourism and real estate development. Each Emirati citizen has long been entitled to a plot for his own villa. But in the early 2000s, when Dubai began allowing property to be owned by foreigners—already attracted by the lack of income taxes—cash flooded in. Four large developers carved up the land. Workers streamed in from South Asia to build villas and skyscrapers clad in glass—not the ideal material in a land of relentless sun, but what the market demanded. The workers lived in camps that were often squalid, in conditions that some said resembled indentured servitude.

The city exploded down the coast. It spread out into the Persian Gulf, onto artificial peninsulas built from titanic amounts of dredged sand; it spread into the Arabian desert. "When you look at how Dubai has been growing, it's just been this obsession with building outward into the desert," says Yasser Elsheshtawy, an Egyptian-American architect who taught at U.A.E. University in Al Ain for 20 years. "There were no limitations. Energy was cheap. You had cars. So why not?"

Sheikh Mohammed's aspiration is like his father's, only grander: He wants Dubai to outcompete the world, to show the world that Arabs can be pioneers again, as they were in the Middle Ages. His strategy has been to attract the world to Dubai. Some 90 percent of the 2.8 million residents are expats living in a place where not so long ago a few thousand Arabs struggled to survive. Dubai's population, young and incredibly diverse—children attend schools with dozens of nationalities, several expats told me proudly—is its main resource. But all those people have to be kept alive in the desert.

These days Dubai has plenty of electricity and running water. Almost all of it comes from a single two-mile-long industrial plant at Jebel Ali. There, in a line of candy-striped smokestacks and evaporator tanks, the Dubai Electricity and Water Authority (DEWA) burns natural gas to generate 10 gigawatts of electricity. The leftover heat is used to desalinate seawater—more than 500 million gallons a day. Gas comes by pipeline from Qatar, with which the U.A.E. severed diplomatic relations in June, and in tankers from as far away as the United States.

Dubai, a tiny emirate we think of as oil rich, depends on imported fossil fuel for life support. One DEWA official, trying to convey to me how that feels, gripped his throat tightly with one hand. But there's an upside to that choking feeling: It can motivate you to change your circumstances.

THE GLOBAL FINANCIAL CRISIS OF 2008 and 2009 brought Dubai's boom to a halt. Tourism plummeted; so did real estate prices. Dubai had to be bailed out of debt by Abu Dhabi. "The economic crisis was probably the best thing that happened to us—a blessing in disguise," says Habiba Al Marashi, co-founder of the Emirates Environmental Group, a recycling and education outfit. "It slowed down the crazy pace of construction."

As the city drew breath, it had several reasons to reconsider its path. At Dubai Holding, Sheikh Mohammed's own development company, "one of the issues was how Dubai was going to source the energy to power all these enormous real estate developments," says energy consultant Robin Mills, who worked there at the time. Green alternatives were in the air: Masdar City, designed by the firm of star architect Norman Foster and billed as the world's first zero-carbon city, car free and solar powered, was just beginning to rise from the sands of Abu Dhabi.

'The economic crisis was a blessing in disguise.'

Habiba Al Marashi, environmental activist

Most important, the price of solar power was plummeting—and it has continued to do so such that now, Mills says, "solar is clearly by far the cheapest form of electricity" in Dubai. This past February, when I visited the Mohammed bin Rashid Al Maktoum Solar Park, 30 miles south of downtown, DEWA was just completing the installation of 200 megawatts' worth of solar panels, and it had signed a contract for the next 800 megawatts—at 2.99 cents a kilowatt-hour. It's planning for 5,000 megawatts at the site by 2030. And unlike many American utilities, it's also encouraging residents to put solar panels on their roofs.

"The solar potential is so great here," Mills says. "Millions of acres of empty desert and plenty of roof space. Electricity generation—for me it's almost 'problem solved.'"

After the profligate boom years, Dubai also is trying to restrain demand for electricity and water. Prices have increased substantially (though they're still subsidized), and new buildings are no longer built as if energy and water were limitless, says Saeed Al Abbar, who heads the Emirates Green Building Council. They may still have glass facades, but they must have solar water heaters, for example, and systems that automatically lower lights and air-conditioning when people are absent. "What I've seen is a huge change," Al Abbar says. He's helping design one of Dubai's first "net zero energy" office buildings, which will produce as much energy as it consumes.

The first net-zero-energy housing development has opened south of town. The secret of the Sustainable City, says its developer, Faris Saeed, a reformed builder of glass towers, is not just the solar panels that shade every parking space and roof terrace, nor the solar water heater that supplies each house. It lies in simple choices—such as packing the 500 L-shaped houses close enough together on narrow streets to shade one another, as the old houses near the Creek do. That allowed the air-conditioning units to be much smaller and cheaper, Saeed says. Extra insulation and reflective windows and paint cut energy use even further. "It's a myth that sustainable has to be more expensive," he says.

All these efforts have begun to pay off. Per capita consumption of water and electricity is falling, and, the government says, so are per capita carbon emissions, the main driver of Dubai's enormous footprint. The average Dubai resident now "emits" less than 18 metric tons a year, just a shade more than the average American. But total consumption and emissions are still growing because the population is. And a Dubai resident still emits three times as much as a resident of New York City—in part because Dubai grew, like many American cities, into a car-centered sprawl. Residents of Saeed's pedestrian-friendly development can walk to restaurants, a grocery store, and a mosque, and a school is on the

Powered by the sun, a 20-foot “Smart Palm” on Jumeirah Beach, near the Burj Al Arab hotel, provides shade and more — Wi-Fi access, phone charger, light post, bulletin board, security camera, emergency call button. Over a hundred will be installed at city beaches and parks.


WiFi UAE

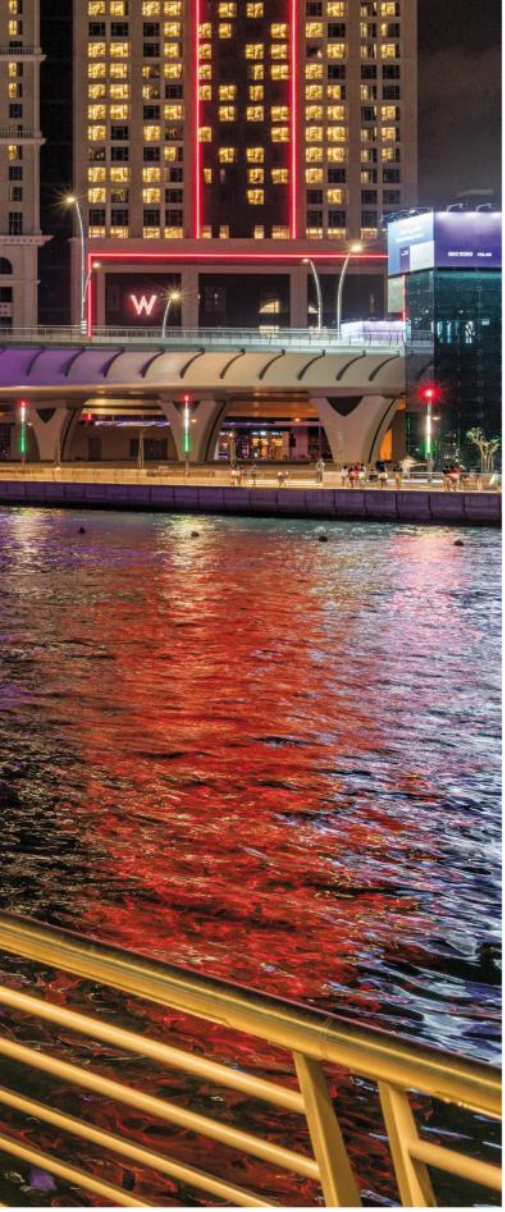
Dubai's dozen golf courses attract many of its 15 million annual tourists and rely on precious water resources. To keep fairways – and its practices – green, the Dubai Creek Golf & Yacht Club, which features an island tee box, began irrigating with treated sewage effluent in 2010.

Opened in 2016, the two-mile-long Dubai Water Canal connects to both the Persian Gulf and the city's natural harbor – the culmination of a plan first envisioned in 1959 by the city's modernizing ruler. The project increases valuable waterfront real estate, slated for retail, housing, public parks and trails, marinas, and a ferry service.

way—but it's still a 10-to-15-mile drive to any of the multiple centers of Dubai. The metro, valuable as it is, doesn't reach the Sustainable City.

Planners are rethinking how people move around the centers themselves. Janus Rostock, chief architect at Atkins, the firm that designed the metro, the sail-shaped Burj Al Arab hotel, and Dubai Opera, is leading an effort to transform the area around Burj Khalifa, the world's tallest building, into a district of ground-floor shops and restaurants that invites people to stroll. Near the Mall of the Emirates, Sheikh Mohammed's own Dubai Holding has planned a mile-long mixed-use development, called Jumeirah Central, where hundreds of buildings will be laid out on small, walkable blocks. They'll be linked by trams to the mall and its metro stop.

All discussions of Dubai's future lead back to the Ruler, and from Emiratis and expats alike, I heard testimonials to the decisive leadership of Sheikh Mohammed. "We don't have a lot of formalities," says Hussain Lootah, director general of the municipal government. "Here projects take days to be done; elsewhere, years." It's not just the lack of red tape—without a free press, political parties, or free elections, there's little



opposition to projects endorsed by the Ruler.

During the boom years this system produced Dubai's headlong expansion and misbegotten projects like the World, an archipelago of 300 artificial islands (shaped like countries) that remain largely uninhabited. But it also produced the Dubai Metro, a smashing success built in less than a decade and opened at the height of the financial crisis. Projects like that give sustainability mavens hope. "This country has developed so quickly," says Tanzeed Alam, of the Emirates Wildlife Society. "It can change quickly too—because the leadership gets behind it."

Perhaps the greatest reason for hope is that environmental imperatives are coming into line with Dubai's economic ones. It's not just that solar energy is cheap. Dubai is pivoting now, says Rostock, because it has to—because it's competing with other cities for business and people, and sustainability is in. "What we have is a willingness and a push to change Dubai and how it's perceived," Rostock says.

But this city has no intention of slowing down. On a wall in Lootah's office, a framed series of aerial pictures shows how Dubai has evolved since 1935, when it was an impoverished fishing village. At the center is a visualization of the future: It shows a coast even more clogged with artificial islands than it is today. Dubai's population is on track to double to more than five million by 2030. The city lives off its expanding footprint: Nearly a quarter of the population works in construction.

The choke point, if one comes, will be water rather than energy. A shallow, almost closed sea, the Persian Gulf is already up to 20 percent saltier than the ocean, and it's getting saltier: Dams in Turkey and Iraq are diverting freshwater, climate change is increasing evaporation—while making Dubai even hotter—and desalination plants are dumping hot brine. In time the water will become ever harder to desalinate and perhaps too salty to support a lot of the marine life that once supported Dubai. "We still feel we can cope," says Lootah. With technology, "everything is possible."

With enough solar power even guilt-free indoor skiing becomes possible—and with climate change, Dubai may need the respite. In the summer, people already go outside as little as possible. By 2100 there may be days so hot and humid that going outside could kill you. Should this city even be here? I put the question to Alam.

"That's the wrong question," he says. "It's more about accepting where we are today and how do we make that better. It's a question of the right to develop and of human beings' right for a better future. How do we make cities better?" □

Senior environment editor **Robert Kunzig** and photographer **Luca Locatelli** covered Germany's renewable energy revolution in our November 2015 issue.

Should We Kill Animals to Save Them?

Trophy hunting helps fund species protection. Critics say the benefits don't match the hype and that killing big game animals today is unethical.

A 13-year-old girl from the United States hauls the carcass of a bontebok back to camp in Eastern Cape, South Africa. She shot the antelope in 2010 and kept the skin and horns.

The people in this story agreed to be photographed on condition that their names be withheld.

Surrounded by more than a hundred African game trophies in his home in Wilmington, Delaware, this hunter says the pursuit has been a passion since he was 12 years old. Hunting “sort of got into my blood,” he says, adding, “I’d like to think I’m a conservationist and a collector.”

A hunter from Texas shot this rhino in 2010 on a game farm in Northern Cape, South Africa – with a tranquilizer dart. The sedated rhino, blindfolded to keep his eyes moist, later got a checkup from a veterinarian. Such hunts offer the thrill of the chase without the kill. A rule change in 2012 generally allows only veterinarians to fire tranquilizer darts; hunters can shoot darts containing vitamins.

By Michael Paterniti
Photographs by David Chancellor

Elephants kept appearing in wrinkled herds, loitering near the dusty pans, in search of water. With the September temperature pushing a hundred degrees at midday, the pachyderms were moving at the edge of the Kalahari Desert in Namibia in a community-run wildlife reserve, or conservancy, called Nyae Nyae, where roughly 2,800 San people live today in unyielding conditions.

The elephants left snapped branches and warm scat in their wake. When they caught our scent, our sweat mixing with the sun-scorched grasses, they broke into a trumpeting jog and were gone.

Later, more materialized on the horizon, in the shade of the camel thorn trees, shades themselves. For such enormous creatures, they were nearly invisible but to the sharpest eyes. And those eyes belonged now to Dam, a short, compact man, a tracker from the local San people who stood in the back of the Land Cruiser.

"Oliphant!" he cried, leaning hard over the right side of the vehicle, picking out tracks in the sand. He tapped on the door, and we came to a whiplashing halt. Dam jumped down, checking a footprint, its edges corrugated and etched inside with smaller bubbles. He motioned, and Felix Marnewecke, the professional hunter and guide on this expedition, popped out of the driver's side door. Strapping, ruddy, and blond, in his 40s, he seemed straight from central casting, wearing a cloth hat and shorts. He stood over the impression for a moment, a quizzical expression on his face, and nodded his head in agreement. If Nyae Nyae's desert scrub is home to San families, it is also home to some of the last, biggest wild elephants in the world. This footprint was proof.

The rest of us unloaded, followed by the tracker they only ever called the Old Man, another tracker in training, and one more San, who was acting as a "game guard" to make sure the hunt was conducted in accordance with the conservancy's rules and quotas. Last to emerge in that swelter was the client himself, an American businessman, who opened the passenger door and reached up to the rack for his gun, a 12-pound, bespoke .470

The head and skin of a lion, prepared for display by a taxidermy shop in South Africa, are boxed for shipment to the American who killed the animal in 2010. In response to dwindling numbers of lions in the wild and doubts about the conservation value of hunting them, the U.S. has since made it harder for hunters to import lion trophies.

Nitro Express double rifle. These guns, costing up to $200,000, are favored for big-game trophy hunting because of their stopping power, and this is what he was here for, of course—a trophy. Two of them, actually. An avid hunter whose adventures had led him to Central Asia to shoot Marco Polo sheep at 15,000 feet and to Africa to shoot a leopard, he was now back in Africa for elephants.

According to Marnewecke, the going rate for a 14-day, single elephant hunt is about $80,000. The trophy hunt limit of five elephants a year in Nyae Nyae represents real money to the San. A portion of the fee is paid directly to community members and to a fund for conservation projects to protect the area's wildlife. As for the elephant trophies themselves, the client would take the tusks home, while the meat would all go to the San.

Marnewecke and his client—anonymous at his request, given the controversial nature of elephant hunts—hoisted their rifles over their shoulders and fell in behind Dam, who took off at the speed of a jackrabbit. Marnewecke turned to me and said, as I stumbled to keep up, "I swear, there's no better tracker in Africa. If it takes 30 miles, he never gives up."

FROM CHARLES DARWIN and John James Audubon to Theodore Roosevelt and Ernest Hemingway, the most enlightened hunters have long viewed themselves as naturalists and conservationists, committed to sustainability among animal populations and the preservation of wild places where they stalk game. The linkage has become inextricable. Revenues of hundreds of millions in federal excise taxes levied on hunters go directly to wildlife management and related

This kudu offered good meat for children living in Namibia's Nyae Nyae Conservancy. Village elders gathered to dance in celebration of the bounty after a German hunter shot the massive bull in 2016. For trophy species, the conservancy charges the hunt outfitter an overall fee, some of which benefits villagers, who also keep the meat. The clients take home the trophy parts.

activities each year in the U.S. alone. And anyone who keeps a freezer full of venison is likely to tell you that the act of killing your own dinner in the wild is more humane than buying the plastic-wrapped meat of industrially raised livestock.

But trophy hunting today, especially of the so-called big five in Africa (elephant, lion, leopard, rhino, and Cape buffalo), brings with it a larger set of moral and financial questions. The sport killing of animals beleaguered in the wild can arouse fierce opposition, even more so if the animal—Cecil the Lion, for example—is named. Biologists estimated total losses of large mammals in protected areas on the continent at up to 60 percent between 1970 and 2005. As big game populations dwindle further under pressure from human encroachment, shifting climate norms, and widespread criminal poaching, there are hunters—the American client in Nyae Nyae, for one—who argue that a thoughtfully regulated and expensive hunt for bull elephants in their waning days makes a sustainable way to protect both species and habitat.

On we went, following the footprints. Every so often Dam would retrace his steps, circling in the dust, until we slowed to a more careful crawl. Coming over a knoll, we saw them at last, *Loxodonta africana*—what seemed to be three bulls, munching on leaves and grass. Marnewecke reached for his binoculars, the American client took his rifle in hand. Everything narrowed to a nervous point. African elephants live to be 60 or 70, and the biggest tuskers usually are older than 45. Tusks are measured by weight, and anything estimated to be over 50 pounds is considered a "shooter" by hunters. The client was looking for

In Nyae Nyae in 2016 the German hunter (above) who shot the kudu seen on pages 78-9 takes aim. He later killed an old bull elephant (left). Hunters argue that killing old bulls does the least harm to the species, but biologist Joyce Poole says older male elephants are "the primary breeders. They're role models for younger males and chosen mates for females."

something in the 70-plus-pound range, but in the end these elephants' tusks were too small. Marnewecke made his determination, turned on his heel, and began walking back to the Land Cruiser. No one seemed disappointed exactly: It was almost enough to have stood in the suburbs of such magnificent creatures.

"The shooting is the last 5 percent of an elephant hunt," Marnewecke said. "I feel quite shitty when an elephant dies, but those elephants pay for the conservation of the other 2,500 that move through here. Trophy hunting is the best economic model we have in Africa right now." It was an argument I'd soon hear other hunters make and a host of activists and biologists tear apart. "In the end it may save this place—and the elephants too."

Standing in the heat and dust of the Kalahari that bright day, elephants at our back, I couldn't help but wonder: Is that really how this works? Can you really kill five elephants to save 2,500? Or start from the other side: Why kill one at all?

SEEN FROM THE AIR Africa can appear as an illusion, rich velds and dramatic rifts, wide deserts and thundering rivers, these seemingly vast stretches of unfettered, unpopulated wild ostensibly forgotten by time and people. At a glance it could be a repository for all our ideas about wilderness at its wildest. And yet today no patch here goes unclaimed, whether it's marked, monetized, or fought over. The animals that roam the land have become commodified, part of a new consumerism, marketed and sold, their brands pitted against each other, their continued existence now a question of human demand, whim,

Villagers in Zimbabwe shared the meat of this elephant, shot in 2009 by an American hunter. They were participants in CAMPFIRE, a program of long standing in which rural groups sell access to their wildlife in return for some of the profit. Once a model of its kind, CAMPFIRE now gets mixed reviews: Too often the money earmarked for communities doesn't reach them or get spent on local improvements.

A giraffe lies crumpled on a game farm in Eastern Cape, felled by a hunter in 2010. Habitat loss and illegal poaching have made giraffes vulnerable to extinction, but in South Africa – where their numbers are increasing – hunting them is legal. Some hunters want a giraffe-skin rug to show off, others the animal itself, taxidermied upright for display in a room with a high ceiling.

and calculation. Wild game is the continent's version of crude oil—and it too will run out someday.

Trophy hunting—the killing of big game for a set of horns or tusks, a skin, or a taxidermied body—has burgeoned into a billion-dollar, profit-driven industry, overseen in some cases by corrupt governments. Many countries in sub-Saharan Africa allow trophy hunting, with varying degrees of transparency and control, establishing yearly quotas meant to reflect the status of species and creating exclusions for highly vulnerable populations. South Africa, for instance, no longer allows hunting of leopards. Kenya has banned trophy hunting outright since 1977, and in Botswana, a comparatively wildlife-rich country, a temporary ban in government-controlled hunting areas went into effect in 2014.

Africa once seemed to have "an inexhaustible supply of nature," says American lion biologist Craig Packer, who has lived and worked on the continent for more than 40 years. But, he says, from 30,000 feet you would see that the habitats are shrinking. "Lions really are becoming more of an endangered species, and hunters should really not shoot these animals for sport unless they can provide positive evidence that they're having a salutary effect on lion conservation."

Biologists make the same argument against the hunting of other big game, including elephants, whose numbers across the continent have fallen sharply in recent years. Demand for rhino horn, elephant ivory, and lion bones, especially in Asia, has ignited a scourge of poaching. But the issue remains complicated, with some place-specific animal populations, such as the elephants of Nyae Nyae, thriving where there's trophy hunting.

Skinners (left) in Namibia in 2011 hold up the pelt of a leopard shot by an American hedge fund manager. Leopards are elusive, and dogs helped track this one down. Namibia later banned the use of dogs because leopard numbers were falling dangerously. Another American (above, at center) hired a cameraman to record his 2016 leopard hunt in Namibia.

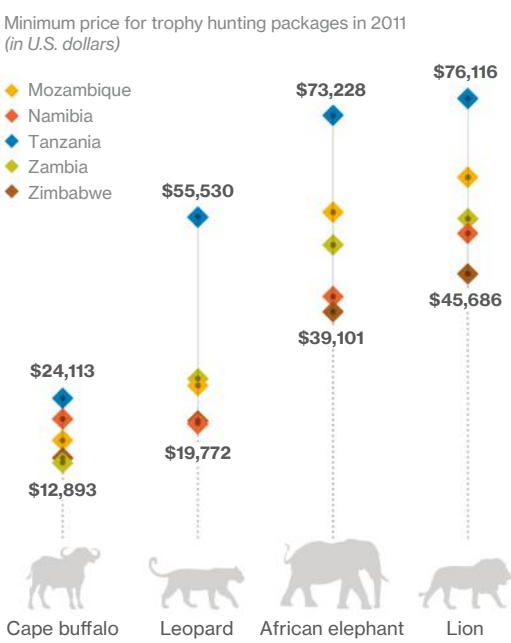
"If you get rid of those conservancies in Namibia," Packer says, "you'd probably get rid of all the wildlife and be left with cattle." He says he and other biologists "are concerned with populations, and that's an abstraction. That's where the real conflict with the animal-rights organizations comes, because in their mind, Fifi must never die. That's where the biologists can sound pretty heartless and cold." For Packer, saving an individual animal misses the point; what's crucial is protecting genetically viable populations as a whole. "I'm not against hunting. There's got to be a middle ground," he says. In his estimation, though, that middle ground isn't exactly in the middle: He believes that trophy hunting is of marginal value as a large-scale conservation tool in Africa.

On the other hand, hunters and government officials often cite a hotly contested estimate by the Safari Club International Foundation, a pro-hunting group with the stated goal of promoting conservation and education, that the roughly 18,000 trophy hunters who come to southern and eastern Africa each year contribute $436 million to the region's GDP. The Humane Society International says the amount for that region is at most $132 million, or .03 percent of GDP.

In a 2013 op-ed in the *New York Times* countering the U.S. Fish and Wildlife Service's proposal to list lions as a threatened species, making it more difficult for Americans to hunt them, the Tanzanian wildlife director, Alexander Songorwa, stated that hunters on 21-day lion safaris paid government fees of up to $10,000 and pumped $75 million into the economy from 2008 to 2011. Packer says the 120,000 square miles of hunting areas in Tanzania need $600 million in

THE PRICE ON THEIR HEADS

The cost of trophy hunts in Africa varies widely by country and animal. In addition to an outfitter's daily rate, the overall cost can include fees to governments and landowners and money for community development support and antipoaching measures.



investment every year, "and you're not going to get that shooting lions for $10,000."

For some, the hunting-antihunting debate boils down to Western environmentalists trying to dictate their agenda to Africa—a form of neocolonialism, as Marnewecke puts it. "Who gives anybody the right, sitting in another continent, to preach to us how we should manage our wildlife?" Hunters make the point that with all the outfitters paying to operate in conservancies and with trophy hunters paying fees for the game they shoot, hunting indeed has made significant financial contributions to the continent, and to habitat protection, while all that antihunting forces have done is make noise.

As for what happens to the hunters' fees, that is notoriously hard to pin down—and impossible in kleptocracies. And anyway, Packer says, when it comes to funding lion conservation, "it's such an underwhelming amount generated by sport hunting, it's no wonder that despite years of lion hunting being allowed in these countries, the lion population has plummeted." The International Union for Conservation of Nature, which monitors animal populations, reports that the number of lions in five populations in Tanzania fell by two-thirds from 1993 to 2014.

Yet hunters say they've helped fund everything from health clinics to schools to water wells to boots-on-the-ground assistance against poachers, all while leaving a lighter footprint on the land than the often cited alternative to killing game: wildlife-watching in the form of photographic safaris. The UN World Tourism Organization estimated that 35.4 million international tourists visited sub-Saharan Africa in 2015 and spent $24.5 billion. Operations designed to attract a higher-end clientele that craves a warm shower, big meal, and cool drink at the end of the day require infrastructure and equipment, maybe including a fleet of vehicles.

There's a danger, some hunters argue, that too many tourists will spoil the very experience they're seeking. "The Serengeti is amazing," says Natasha Illum-Berg, a Swedish-born professional buffalo hunter based in Tanzania, who, like Marnewecke, leads clients into the bush for "hunting experiences" and trophies. "The Ngorongoro Crater is a miracle. All these national parks that are filled with minibus after minibus of photographic tourists—it's fantastic," she says, noting that the minibuses also put pressure on those iconic wildlands. "But what about the other areas?" she says. "How many people have been to the area I work in, that's 500 square miles? This year maybe 20 people." Without trophy hunting, Illum-Berg argues, there would be no antipoaching there, no management. "I keep on saying: Give me a better idea than hunting as long as it's sustainable." She adds, "The big question in the end is, 'Who's going to pay for the party?'"

THE EARLIEST EVIDENCE of an elephant having been killed by human hands dates back to a blue-mud swamp in Siberia nearly 14,000 years ago.

MONICA SERRANO, NGM STAFF; MEG ROOSEVELT
SOURCE: PETER A. LINDSEY, VERNON BOOTH, AND OTHERS, *PLOS ONE*, 2012

The spine of a woolly mammoth found at the confluence of the Ob and Irtysh Rivers seems to have been penetrated by a man-made weapon that left flake traces of stone inside one of the vertebrae. The tusks, we might imagine, weren't displayed in a trophy room back at the hunter's cave.

But hunting is more than a quid pro quo for sustenance. At some moment in our dawning consciousness, hunting became equated with status, virility, and power. Assyrian carvings from 650 B.C. depict lions being released from cages for slaughter by a chariot-riding king. The Maasai have long killed lions as a rite of passage.

With the advent of better weaponry, hunting also evolved as a sport, one with class stratifications, micro-cultures, and occasional egregious examples of waste. In records from 1760 for Snyder County, Pennsylvania, two hunters shot more than a thousand animals, including black bears, mountain lions, bobcats, wolves, foxes, bison, elk, deer, wolverines, and thousands more smaller creatures, dressing some of the animals and throwing most of the carcasses into a bonfire.

Theologians were among the first to criticize such wasteful butchery. By the late 1700s an anonymous British hunter had penned *The Sportsman's Companion, or An Essay on Shooting,* advocating fair chase and setting forth "directions to gentlemen" in the field and forest, including limiting the number of game animals killed. Those rules were expanded and refined during the next century. In 1887 Teddy Roosevelt founded the Boone and Crockett Club, a group of influential American hunters who were worried about preserving swaths of their country's wilderness and became instrumental in building the U.S. National Park System.

In 1934 at the Norfolk Hotel in Nairobi, Kenya, some white hunters established the East African Professional Hunters' Association. It promulgated a kind of honor code and pushed for laws and regulations, including a ban on shooting nearly all female animals and on shooting animals at water holes or near vehicles. While the members worked to conserve hunting grounds, they also eliminated huge amounts of game from the continent. Today technology has taken a quantum leap forward, with drones, video of the hunt, and high-powered rifles equipped with laser range finders.

Meanwhile "kill shots"—images of hunters posed with their dead quarry—have created viral sensations and stirred animal-rights activists and the general public to fulsome disgust. People were inflamed when Minneapolis dentist Walter Palmer hunted and killed Cecil, the popular lion from Zimbabwe, in June 2015. Controversy resurfaced in July 2017 when Cecil's son Xanda was shot on a legal trophy hunt.

With more than half the planet's population living in cities, our relationship with the wild has become increasingly divorced from our everyday reality. We're now less a part of that wild world from rain forest to veld than consumers of it. Yet if we eat meat or wear and use leather products, we too are hunters of a sort.

Within the hunting community our hurry-up, have-it-all mentality—our ceaseless consumptive entitlement—has begun to manifest itself in troubling ways. Eschewing the time and cost of an African trophy hunt involving fair chase, some hunters have turned to canned hunting—the killing of often habituated animals in confined areas—baited hunting, herding animals with helicopters, or the shooting of their prey from the back of Land Cruisers. In Tanzania there have been reports of foreign hunters gunning down animals, including pregnant females, with AK-47s. In a hunting area called Loliondo that the government has leased long term to officials from the United Arab Emirates, local Maasai have reported transport jets leaving with game of all variety, dead and alive. Social scientists writing recently in the journal *Biology Letters* describe a kill-and-tell generation of hunters exhibiting "show-off behavior" by propagating their own kill shots on social media, sometimes in poses that undermine the dignity of the animal whose life they've just taken.

In South Africa, which has some 2,000 wild lions, canned lion hunting has grown into a more than $100 million industry, with in excess of 200 facilities raising about 6,000 of the big cats for easy killing. According to Ian Michler, a South African safari operator and photographer who

A hunter carries the pelt of a mountain lion he shot this year in southern Utah. Winter is prime hunting season because the cats are easier to track on snowy ground. Each season the state sets a hunt quota, a number determined in part by how many livestock lions killed the year before. In 2016 they killed 416 sheep and other farm animals, and during the 2016-17 season hunters took 399 lions.

investigated the canned lion industry for the 2015 documentary *Blood Lions,* the animals are caged and bred sometimes under terrible conditions. The young are taken from their mothers and brought to petting zoos. When male lions grow into adulthood, many are shot and killed for "hunting" fees that are much lower than the cost for a wild lion on a standard 21-day hunt ($5,000 to $15,000, versus $50,000 and up). And the trophy is virtually guaranteed. "It's appalling," Michler says. "It's perverse behavior."

Canned hunting has another deleterious effect. While hunters happily take the pelt and head, and the claws and teeth once were sold in the tourist shops of Nairobi and Zanzibar, today the bones are most in demand—shipped to Asia either to produce traditional medicines or to be repackaged as "tiger bone wine," made from crushed bones and Chinese herbs and marketed to the upper class as a health tonic and aphrodisiac. This year South Africa authorized the export of up to 800 lion skeletons, and the worry among biologists, conservation groups, and animal-rights activists is that by legitimizing and allowing the trade, the country is spurring more demand for lion bones and more killing of the continent's remaining 20,000 or so wild lions.

As it turns out, some of the most vocal critics of these hunting practices are hunters themselves.

"If we are not able to convince the majority of people that hunting is morally in order," says Kai-Uwe Denker, a renowned professional hunter in Namibia, "there is no future for us." In the face of bad publicity and bad behavior, some hunters have fallen back on an economic argument—that their presence in Africa provides jobs, that it's a viable strategy for poverty alleviation. But Denker disagrees. "I see a very big danger in promoting only the financial side. Livelihoods, income generation, job creation—this is an additional thing. You cannot justify immoral things with money."

When I met Denker in a valley in the Erongo Mountains, where he lives 25 miles off the grid in a house he built, he lamented the intrusion of humans on the African landscape. According to him, hunting, when done properly, brings you into "a conversation with your own death." As we spoke in the shaded portico, the sun flashed off a blanched elephant skull set nearby, and the wind stirred the acacia, blowing away a certain noon deadness that often grips the desert. Time seemed to bend to the prehistoric. Tall and slender, wearing a torn shirt and short shorts, Denker is legendary for walking up to 40 miles in a day of hunting. He also abides by a strict set of principles that includes hunting game, such as elephant and kudu, that have unfenced free range in historic habitat and shooting only older nonreproductive animals without fixating on large trophies.

"Many of the antihunters, they criticize hunting as perverted," Denker said. "Hunting as such is not perverted. It's in our genes. If hunting is immoral," he continued, "I will stop immediately. But it will be the end of nature."

IF IT PAYS, IT STAYS. It was a phrase I heard over and over again, in myriad discussions about African conservation, in part to describe how money has changed the mind-set of rural populations regarding the value of big game. Too often people have seen an elephant destroy their annual crop, and some have known the pain of a lurking lion taking a child for food. Here there's no mythologizing or fetishizing, no fund-raising around a fuzzy face: The leopard is a killer, the rhino is a ruiner. To protect themselves against the enemy, villagers often shoot and poison these intruders, without an iota of sentimentality. And yet, the argument goes, if those animals are worth money to a local community, that community will work hard to conserve and protect its assets.

This is something I witnessed firsthand. My time in the Kalahari coincided with Nyae Nyae's annual game count, in which 50 or so San camped for three nights at various water holes, trying to account for the number of animals within 3,500 square miles of sand, bush, and baobab trees.

As fragile as it is, Nyae Nyae might be called a conditional success story, in part because the hunt quotas have been methodically monitored and increased over the years. On occasion cattle have threatened to overrun the conservancy, but the big game have returned, and the menu of animals offered to hunters includes leopard, kudu,

Game ranches in the U.S. feature dozens of exotic species, from zebras and yaks to scimitar-horned oryx, which are extinct in the wild. A 15-year-old novice gets field training at FTW Ranch, in Barksdale, Texas, in 2016. The boy later shot an aoudad, or Barbary sheep, which he skinned, cleaned, and prepared for meat processing.

and wildebeest, with prices set by a management committee of five members of the conservancy. Profits are shared communally: Last year each adult over 18 in Nyae Nyae was issued about $70. "We have enough," the chief, Bobo Tsamkxao, told me as he sat in his yard in front of a disintegrating house, his wives sitting in a row among children and litter. The arrangement also requires that the professional hunter employ and train local people and contribute toward development projects such as schools and health clinics.

Nyae Nyae became Namibia's first conservancy, locally owned and run, in 1998. Every five years the conservancy is put up for tender, with professional hunters offering bids to the San for the right to establish an on-site operation. Last year the winning bid was more than $400,000, a rich number in large part because the elephants have become so big and valuable. The professionals sell hunting packages to clients to recoup the tender offer, cover expenses, and make a profit. Many operate on more than one conservancy; some string together enough to build their own little fiefdoms.

When I was there, in September 2016, Marnewecke had just learned that he'd been outbid and would lose his Nyae Nyae operation by season's end. "I'll miss the San," he said, but he had another conservancy to the north that would keep him busy. What worried him most was the Jenga-like fragility of Nyae Nyae, and that irresponsible people might come with their own selfish designs—crisscrossing the conservancy with new roads and upsetting the equilibrium.

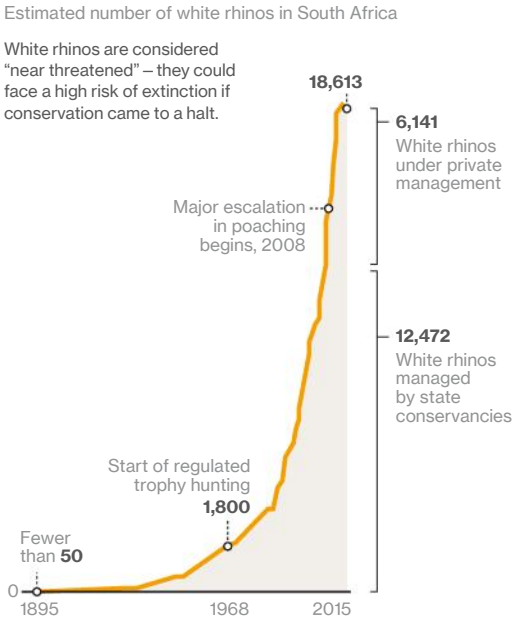
While Namibia has turned wildlife management over to the local population, governments in places such as Tanzania have taken an

A pair of hunters weigh a black bear shot in Maine in 2016. The bear had been baited, a practice that involves placing caches of food to draw the animals to a particular spot in the forest before the hunting season begins. In Maine the numbers of bears, which are not endangered, have been rising. Mainers recently rejected a proposal to ban baiting and hunting with dogs.

Hunters bring the first whitetailed deer of the regular firearms hunting season to a market in Jerome, Michigan. Before the deer are butchered, some will be hung along a “buck pole” to see who bagged the largest animal. Unlike trophy hunting in Africa, where big game expeditions cost tens of thousands of dollars, deer hunting in the U.S. is pursued widely. In Michigan alone, nearly 600,000 people hunt deer.

RISE OF THE WHITE RHINOS

Nearly extinct in South Africa a century ago, southern white rhinos rebounded thanks to conservation efforts, limited trophy hunting, and the harvesting of horns, which regrow. But with a recent surge in poaching, those rebounding numbers are leveling off.



opposite tack, directly owning and leasing hunting grounds. Critics say that no country should be in the business of selling and profiting from dead animals. When coffers run low and funds are needed, they say, hunting quotas get raised without regard for the animals' population numbers. And in those hunting areas where funds aren't reinvested, there's no wildlife left to hunt. That could explain how 40 percent of Tanzania's designated hunting areas have been emptied of game animals during recent decades. A promotional video that surfaced in 2014 shows a hunting company, Green Mile Safari, guiding hunters from the United Arab Emirates on a disturbing shooting party. The minister of tourism and natural resources said the party violated a host of laws by, among other things, firing automatic weapons, hunting female and young animals, and allowing a minor to hunt. The government banned Green Mile from conducting hunts in Tanzania in 2014 but reissued the company's license last year, leading to accusations of corruption. No arrests were made, and Green Mile claims that the guide was at fault.

In the Selous Game Reserve ecosystem, a prized trophy hunting destination, aerial surveys estimate the elephant population at some 15,000, down from perhaps 50,000 as recently as 2009. "Why has the Selous been such a killing field?" says Katarzyna Nowak, a conservation scientist associated with the University of the Free State, Qwaqwa, in South Africa. "If hunters are coming in from all around the world, and you're really pumping money earned from trophies back into the Selous for conservation and antipoaching, where have all the elephants gone?"

Craig Packer sees the conservation of African wildlife in practical terms: If hunters were shooting lions "for a million dollars and returning a million per lion directly into management, they would be on solid ground. But lions are shot for tens of thousands of dollars, and very little of that money goes back to conservation." With two billion dollars a year we could save and protect the wildlife in Africa's national parks, Packer says. But that would have to come from international partners such as the World Bank, eco-philanthropists, and nongovernmental organizations.

Some trophy hunters say it's not fair to blame them. Make of their sport what you will, they don't set the fees or determine the quotas. And they can't control endemic corruption in some countries, even if they indirectly feed it. Some claim to share the concerns of environmentalists who see collapsing habitats and dwindling populations. Kevin Reid, a big-game ranch owner in Texas, says he raises endangered African species not only for the sport of trophy hunters but also to create "a seed vault of animals," including oryx and white rhinos, to help rewild Africa once its problems have been sorted. "We're trying to reverse extinction," Reid says. In the never ending ironies of the issue, though, the near extinction of African elephants, rhinos, and lions comes today courtesy of the barrel of a gun.

MONICA SERRANO, NGM STAFF; MEG ROOSEVELT
SOURCES: MICHAEL KNIGHT AND RICHARD EMSLIE, IUCN SSC AFRICAN RHINO SPECIALIST GROUP

Perhaps, then, it boils down to another set of questions: In light of who we've become as a species, what new form has nature taken, and what new rules might be practiced there? Might we owe it to the natural world, after bunging it up so badly, to act differently—less acquisitively, more generously—toward it? Might it now be time to stop killing the dwindling herds for sport and display? Or, perhaps more difficult to ponder: Will these trophies be all we have left someday, tokens of a wild nature we once knew?

ON THE 12TH DAY of the elephant hunt in Nyae Nyae, in the rising heat of the day, Dam, the tracker, picked up the marks of three bulls moving together. Once Marnewecke and his client saw the elephants from a mile away, they knew they were big and approached them from downwind so as not to be detected. Two of the bulls were in front of them, but the largest and oldest stood apart and behind. So they maneuvered out around the others and came up on the third as he began to walk toward a clump of brush. The client crouched low on one side as the old bull—sagging and on his sixth molars, half ground down already, which means he was well on in the last season of his life—unwittingly ate on the other side.

Would killing an old bull like this one help save all those other elephants in Nyae Nyae?

Old bulls, says Caitlin O'Connell, a biologist and elephant researcher focused on how the animals communicate, are a font of wisdom, deciding when and where the herd will move in search of water, imposing an order on pachyderm society. "Contrary to myth, elephant bulls are very social creatures," she says. "They move in groups of up to 15, and they maintain a strict hierarchy. The older bulls exert a very important regulatory impact on the herd and an emotional-social influence on the younger bulls." Younger bulls in musth, a heightened state of aggression during which testosterone levels can be 10 times as high as normal, will be more likely to fight each other when an older bull is absent.

At 15 yards, the client could see every wrinkle draping the elephant. He aimed his 12-pound double rifle with its hand-engraved silver stock and fired directly at the heart. The bull turned and began to run, 30 yards before it fell. The client put one more shot in the brain, and it was done. The tusks weighed out at more than 70 pounds each. Within six hours the carcass had been stripped by the San, who took roughly three tons of meat for their families.

Two days later the hunting party found another big bull. The client fired a shot, bringing it down—but then, as another bull gave chase, he and Marnewecke ran for at least half a mile before the elephant lost interest in them. Eventually the process repeated: the flensing of the skin, the stripping of the bone, the feeding of families. With that elephant, Marnewecke's quota for the year was filled. His client flew home; the tusks of the two elephants would follow, destined for his trophy room back in America.

I thought about those tusks in the weeks that followed, possessions now, totems of a fraught accomplishment. They were all that was left of two 15,000-pound sentient beings. Which brought me to Bobo Tsamkxao, the San chief, and his wives and children, and how they and others in the community would eat from those animals. And how they would receive money, at least indirectly, from those animals as well. But something still seemed askew: a paying client killing a vulnerable animal to feed the San or conserve Nyae Nyae's land. Even if hunting is in our genes, as Denker said, the essential question remained: Was it moral to kill such an imperiled creature at this moment in our history?

After the hunters had packed up, the herds—sometimes called a "parade" of elephants, or even a "memory" of elephants—searched for water in temporary peace, unaware that another season would bring another group of hunters. We must imagine: Memories of elephants wandering all that contested space, some already with price tags on their head, there for us as things of wonder. ▯

Michael Paterniti, a contributing writer at the *New York Times Magazine* and a correspondent for *GQ* magazine, is at work on a book about the North Pole. **David Chancellor** has spent years documenting the complex relationship between hunters and their prey. This is his first story for *National Geographic.*

Without a Home, and Without Hope

Members of the Rohingya Muslim minority have fled violent repression in Buddhist Myanmar for generations. In neighboring Bangladesh, refugee camps offer asylum, but life there remains bleak.

A refugee stands on a plateau near her hut in a newly built part of Kutupalong camp. Most Rohingya who live in this section arrived recently, fleeing a campaign of terror in Myanmar launched by the military.

BY **BROOK LARMER**
PHOTOGRAPHS BY **WILLIAM DANIELS**

Dance!" shouted the army officer, waving a gun at the trembling girl. Afifa, just 14 years old, was corralled in a field with dozens of girls and women—all members of the Rohingya Muslim minority. Soldiers had invaded her village in western Myanmar that morning last October. The men and boys, fearing for their lives, had dashed into the forests to hide.

After enduring an invasive body search, Afifa had watched soldiers drag two women into a rice paddy before others turned their attention to her. "If you don't dance at once, we will slaughter you," the officer warned. Choking back tears, Afifa swayed back and forth. The soldiers clapped rhythmically, and the officer slid an arm around her waist.

"Now that's better, isn't it?" he said, flashing a smile.

The encounter recalled by Afifa marked only the beginning of the latest wave of brutality against the estimated 1.1 million stateless Rohingya who live, precariously, in Myanmar's Rakhine state. The Rohingya are one of the world's most persecuted minorities. They are Muslims in a nation dominated by Buddhists. The Rohingya claim they are indigenous, and many are descended from settlers who came in the 19th and early 20th centuries. In 1982 the then military government stripped them of their citizenship. They are now considered illegal immigrants in Myanmar as well as in neighboring Bangladesh, where many have fled.

Five years ago clashes between Buddhist and Muslim communities left hundreds dead, mostly Rohingya. With their mosques and villages torched, 120,000 Rohingya were forced into camps in Myanmar. This time the Burmese military unleashed a four-month campaign of terror that included executions, mass detentions, razing of villages, and systematic rape, according to the United Nations and human rights organizations. The army onslaught, which began after an attack on border posts by suspected Rohingya militants left nine policemen dead, triggered an exodus of about 74,000 Rohingya into crowded refugee camps across the border in Bangladesh.

Before the soldiers left Afifa's village, they set fire to the harvest-ready rice fields, looted houses, and shot or stole all the cattle and goats. "We didn't want to leave our home," Afifa's father, Mohammed Islam, told me in March, when five of the family's 11 members staggered into a refugee camp in Bangladesh. "But the army has only one aim: to get rid of all Rohingya."

Yanghee Lee, the UN special rapporteur for human rights in Myanmar, said the army attacks "very likely" amount to crimes against humanity. The army rejects the claim, as does Aung San Suu Kyi, Myanmar's first truly civilian leader after a half century of military rule. "I don't think there is ethnic cleansing going on," she told the BBC. Winner of the Nobel Peace Prize for her long struggle against the military junta, Aung San Suu Kyi has dismayed rights activists by not speaking out against the atrocities, much less bringing perpetrators to justice. In June her government refused to grant visas to members of a new UN fact-finding mission. "We had a very big hope that Suu Kyi and democracy would be good for us," says Moulabi Jafar, a 40-year-old shop owner who fled to Bangladesh. "But the violence only got worse. That came as a big surprise."

Afifa, her father, and three of her siblings spent five months on the run. On their first attempt to cross the Naf River, which separates Myanmar from Bangladesh, a Burmese patrol boat opened fire, capsizing their boat and killing several refugees. They eventually joined about 500,000 Rohingya refugees, many crammed into squalid camps along the border, while her mother and five children remained in hiding in Myanmar.

In Balukhali, where some 11,000 recent arrivals

NGM MAPS

Rohingya refugees queue outside Kutupalong camp near the town of Cox's Bazar, waiting to receive staples from the World Food Programme. About half a million Rohingya have fled Myanmar for Bangladesh.

have turned the forested hills into a dusty hive of bamboo huts and black tarpaulins, Afifa is one of the luckier ones. Others in the camps have suffered more. Nur Ayesha, 40, pulls back her scarf to reveal burns across her face; the military, she says, set fire to her house while she was still inside. Ajim Allah, 14, shows me his shriveled left arm, shattered by a police bullet when he emerged from a madrassa last October; three of his friends died of gunshot wounds that night.

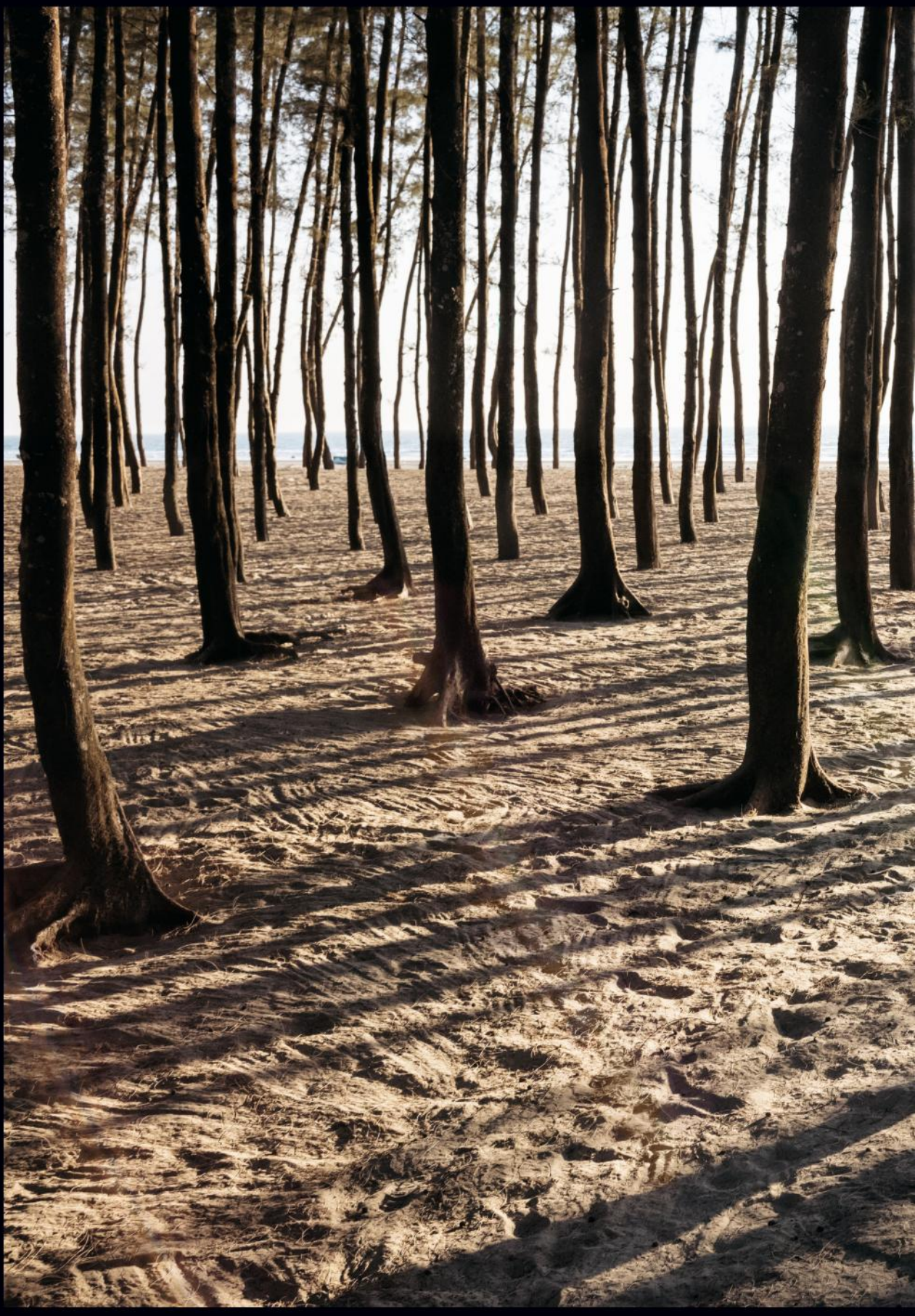
Yasmin, a 27-year-old from Ngan Chaung village, recounts how soldiers took turns raping her in front of her five-year-old daughter. But the worst moment came when she went to look for her eight-year-old son—and found him in a rice paddy, a bullet hole in his back. "There's no hope for us there anymore," she says, tears rolling down her cheeks.

There is little hope in Bangladesh either. Rohingya can't get proper jobs, enroll children in schools, or access basic health care. On the road outside camp, clusters of refugee women beg for money. Men find sporadic work in the paddies or salt farms, but wages rarely exceed a dollar a day. And Bangladesh, already poor and overpopulated, doesn't want to host them for long. The government is floating a plan to move them to a remote island in the Bay of Bengal.

The last time I saw Afifa, she was sweeping a rectangular patch of dirt—the site of the family's future hut—while her father secured bamboo poles at each corner. Islam, in his white skullcap and tunic, attended Friday prayers that day for the first time since he fled Myanmar. But the misery has continued. In late May a cyclone ripped through, destroying the family's shelter—and hundreds of others in Balukhali camp. Nobody died, and his wife and other children finally made it to Bangladesh. Still, food is scarce, the monsoon rains continue, and there are reports of renewed military operations in Rakhine. As a neighbor lamented: "Bad days for us never end." □

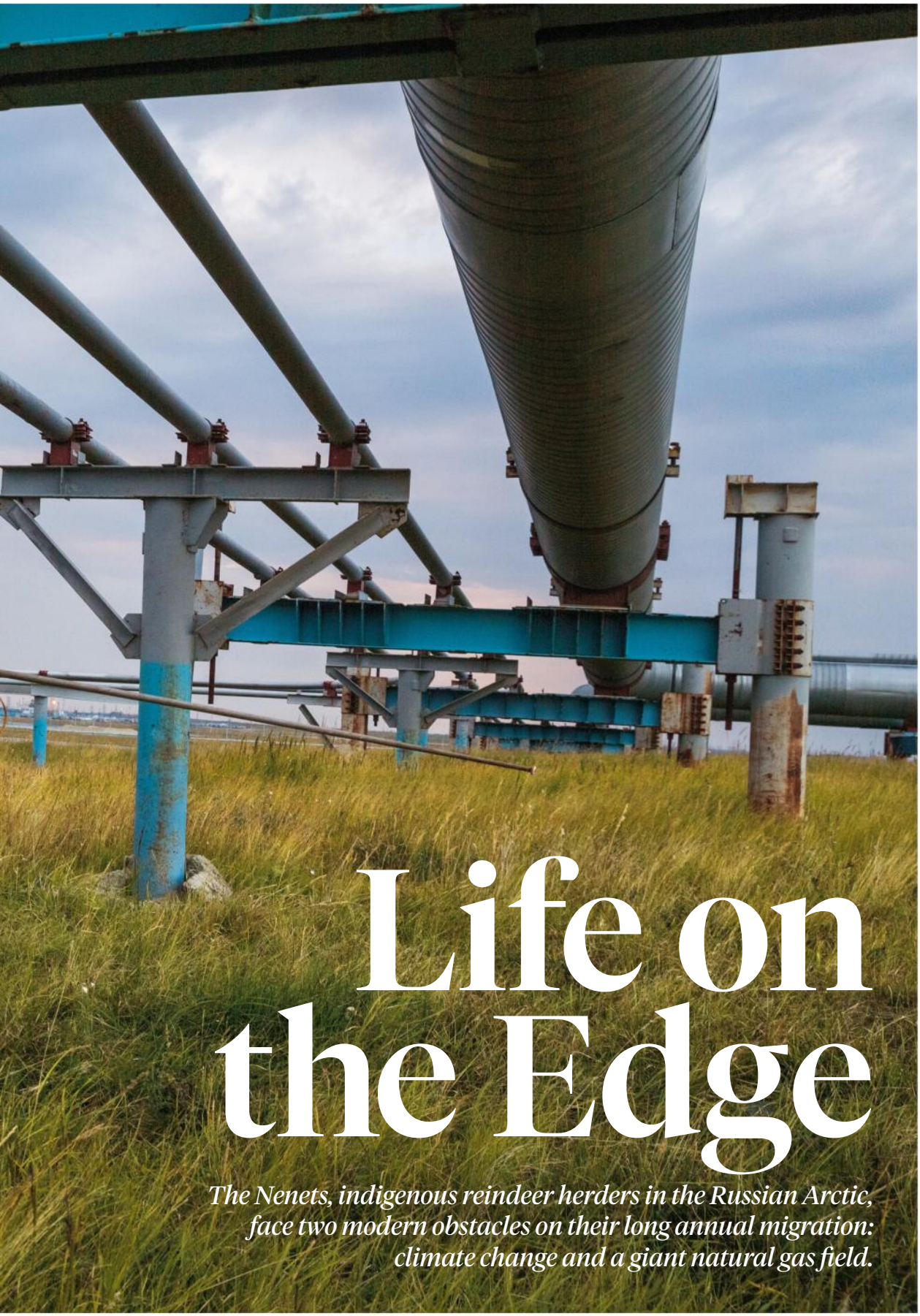
Above: Nur Ayesha says she was burned on her face and arm when the Burmese military torched her house while she was in it. She has received treatment at Kutupalong. Below: Men pray at a mosque being built from bamboo at Balukhali, a refugee camp in Bangladesh. The Rohingya are Muslims, while Buddhism is the dominant religion in Myanmar. Buddhist firebrands have stirred up hatred for the minority Rohingya.

Above: Early in the morning, family members warm themselves around a fire in an alley in Kutupalong. Refugees construct their huts from branches, leaves, and black plastic sheeting. Many of these flimsy shelters were ruined in May by a cyclone. Below: With no access to Bangladesh's health facilities, Rohingya women with a malnourished baby wait to be seen by medical professionals who work for international nonprofits.



Some Rohingya live outside the camps near Cox's Bazar. This man lives in a settlement on the Bay of Bengal, near trees planted to prevent erosion and close to a hotel catering to tourists drawn by the beach.

Nyadma Khudi, a Nenets herder, leads reindeer under a pipeline at the Bovanenkovo gas field on Siberia's Yamal Peninsula. When gas lines were new, the animals shied at them. Now they follow Khudi without hesitation – as they must to reach summer pastures in the north.



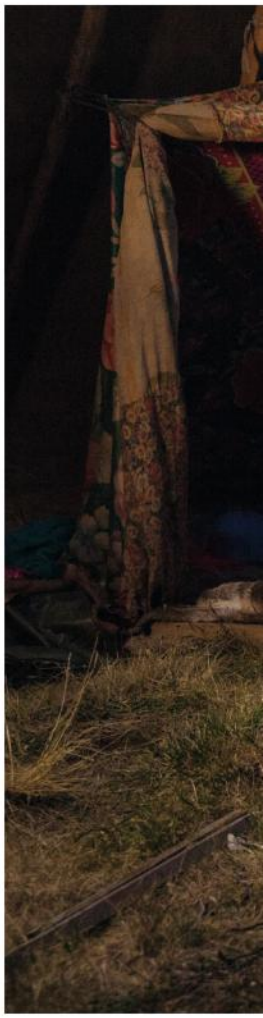
Life on the Edge

The Nenets, indigenous reindeer herders in the Russian Arctic, face two modern obstacles on their long annual migration: climate change and a giant natural gas field.

Five-year-old Pavlik Khudi, Nyadma's grandson, urges his mother, Edaine, to go faster. He lives all year with his parents, making the 800-mile annual migration. But at age seven he will enter a state boarding school, like other Nenets children, and spend most of the year away.

Nyadma pins a young bull so that his son Gosha can cut off the velvet antlers. A trader will pay about $11 a pound for them; the living tissue and blood inside are prized in Chinese traditional medicine. The process is painful to the animal.

By Gleb Raygorodetsky
Photographs by Evgenia Arbugaeva



The Puikos, a Nenets herding family, enjoy a lunch of whitefish soup inside their chum, or tent. In summer the Nenets depend on the fish they catch in lakes and rivers along their trek up and down the Yamal Peninsula. In winter they eat more reindeer meat.

Clad in a camouflage jacket, the mosquito netting unzipped from his hood, Yuri Khudi squats by the fire inside his large chum. Outside, seven more of the teepee-like tents cluster in a semicircle. Swells of Siberian tundra roll north toward the Arctic Ocean; a reindeer herd grazes on a distant crest. It's mid-July, and the group of Nenets herders that Yuri leads are about halfway through an annual trek that takes them 400 miles north on the Yamal Peninsula to the Arctic coast—in normal years, that is.

"It's been three years since we have made it all the way to our summer pastures by the Kara Sea," Yuri says as his wife, Katya, pours him a steaming mug of tea. "Our reindeer were too weak for the long journey." In the winter of 2013-14, an unusual warm spell brought rain to southern Yamal; the deep freeze that followed encased most of the winter pastures in thick ice. The reindeer, used to digging through snow to find lichen, their main winter food, couldn't dig through the ice. In this herd and others, tens of thousands starved. Now, in the summer of 2016, the survivors are still recovering.

The canvas entrance of the chum flaps open, and a reindeer, antlers down, bursts inside. It pauses in front of the fire, shakes vigorously, and flops down to chew its cud meditatively.

"This young cow lost her mom, so we raised her ourselves inside the chum," explains Yuri, taking a cautious sip of tea. "She doesn't like mosquitoes. Hopefully next year she'll have a calf of her own. We're down to about 3,000 reindeer now, half of our usual herd."

The Nenets have undertaken this annual migration for centuries, and at 800 miles roundtrip, it's one of the longest in the world. Yuri's group, called Brigade 4, is a relic of a Soviet collective—under Soviet rule the Nenets endured decades of forced collectivization and religious persecution. They survived centuries of Russian rule before that. Through it all, they've managed to sustain their language, their animist worldview, and their nomadic traditions.

"The Nenets are one of the most resilient indigenous groups in the Arctic," says Bruce Forbes of the University of Lapland in Finland, a geographer who has studied them for decades.

Today, however, that resilience is being tested in new ways. Climate scientists say the kind of "rain on snow" event that diminished the herds three years ago will become more frequent and intense in the Arctic as the climate warms. As I talk to Yuri, the region is suffering another record-hot summer; the thermometer has already hit 94°F. It hasn't rained for weeks, and it's hard for reindeer to pull the loaded sleighs across the dry tundra.

Before the summer is out, a boy and more than 2,300 reindeer will die from anthrax on southern Yamal, and dozens of people will get sick—a direct result of thawing permafrost, which allowed animal carcasses buried during an outbreak in the 1940s to reemerge, still bearing infectious microbes.

Yet climate change isn't even the greatest threat to the Nenets. Development is. Russia's quest for new sources of hydrocarbons has encroached on pastures that were already tight for the estimated 255,000 reindeer and the 6,000 nomadic herders that live on Yamal. And it has restricted the essential migration of some of the herds. The Bovanenkovo gas field, the largest on Yamal, sits directly in Brigade 4's path. The herd must cross the field, with its roads and pipelines, to get to the summer pastures.

The Nenets have always lived close to the edge; in their language, Yamal means "edge of the world." But these days at least some of them seem precariously close to falling off.

PERCHED ON THE LEFT SIDE of the sleigh, his legs firmly planted on a runner, Nyadma Khudi raps the backs of his reindeer with a *tyur*—a long pole of polished wood ending in an antler knob. Grunting softly, he urges the four bulls forward through shrub willows and clouds of mosquitoes. Nyadma is Yuri's elder brother and a former brigade chief. As a sign of respect, his caravan of several sleighs is in the lead as Brigade 4 presses on toward Bovanenkovo.

After about an hour, Nyadma suddenly stops. "We'll break here for a bit, to let everybody catch up," he says, as he fishes a ringing cell phone out of his capacious, bell-shaped reindeer-skin coat. Other sleighs pull up behind us. The harmony of clicking reindeer hooves soon gives way to the cacophony of dial tones and human chatter as

Well defended against summer mosquitoes, cousins Kristina (left) and Vera (right) Khudi ride the “silver dragon” – a pipeline that collects natural gas from wellheads at Bovanenkovo. Herders encounter many pipeline sections on their annual migration.

the Nenets enjoy one of the few perks of having a mega-development in their backyard: We're now within range of Bovanenkovo's cell phone tower.

I step away from the sleighs to stretch my legs. The midnight sun fills the lakes and waterways ahead of us with an amber glow. A distant hum, like that of a jet before takeoff, draws my attention; it's coming from the gas field, still many miles away.

Yamal's natural gas is the cornerstone of Russia's energy strategy—the new source that will replace declining fields to the south and east of here—and Bovanenkovo is the cornerstone of Yamal. It's operated by Gazprom, the state-owned company that produces most of Russia's natural gas and supplies more than a third of the European Union's imports. According to Alexey Miller, Gazprom's CEO, Yamal could produce as much as 13 trillion cubic feet of gas a year by 2030—more than a third of Russia's projected total. Bovanenkovo alone has confirmed reserves of nearly 173 trillion cubic feet. Linked to the mainland by its own airport and a 350-mile railroad, and to Russia's gas grid by two 750-mile pipelines, Bovanenkovo is also a launchpad for Gazprom's further expansion into the Russian Arctic.

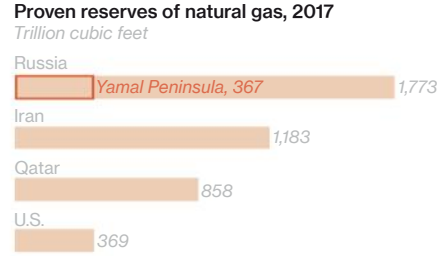
Global warming is the greatest obstacle to that ambitious agenda. Alexey Osokin is deputy director of Gazprom's engineering center, which has collected and analyzed 25 years of weather and permafrost data from meteorological stations and gas wells around the Yamal Peninsula. "One cannot argue with the data," he says. "There is no doubt that the climate is warming." In summer, thawing permafrost undermines the stability of Gazprom structures. The company has had to install refrigeration units to keep the ground frozen around wellheads and pipelines.

Some effects of thawing permafrost are hard to prepare for, Osokin says. In the summer of 2014 a gaping crater, 130 feet wide by 115 feet deep, suddenly formed in the tundra 19 miles southeast of Bovanenkovo. Experts blame an eruption of methane gas that had been trapped under frozen ground. They worry that if a similar eruption were to occur under the gas field itself, it could cause considerable damage. In the summer of 2017 two

The Paths of Resilience

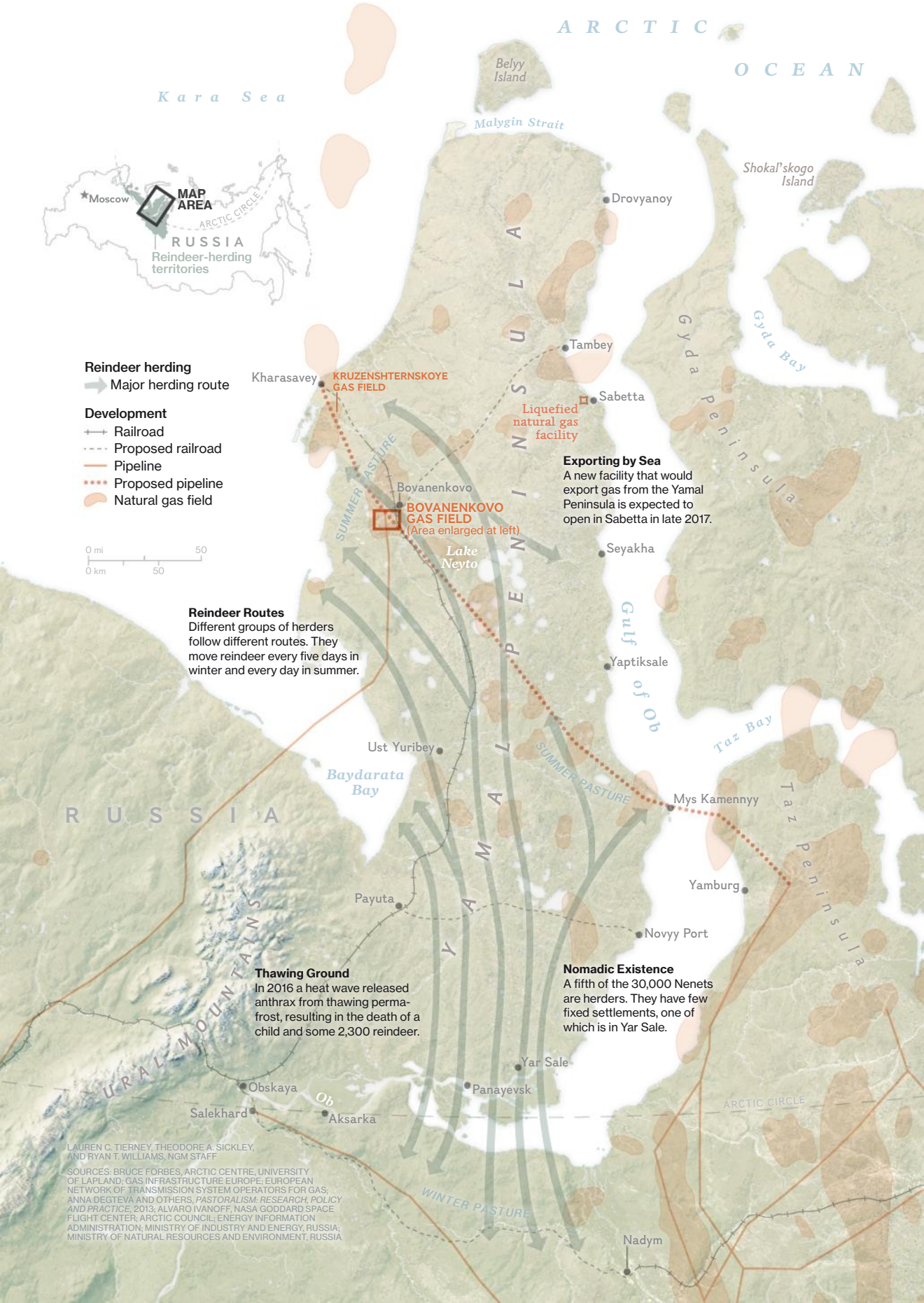
For centuries Nenets reindeer herders have migrated to summer pastures on the Yamal Peninsula, returning south in winter. Climate change, with its summer droughts and winter rains, challenges that way of life—as does Russia's development of Yamal's natural gas.

LUCRATIVE LANDS
The sparsely populated Yamal Peninsula holds more than a fifth of Russia's natural gas reserves and about as much as the entire United States.



THE BOOM AT BOVANENKOVO
To get at 173 trillion cubic feet of gas at this field, the Russian company Gazprom has built roads, well pads, and pipelines that interfere with a reindeer migration corridor.

DERIVED FROM SATELLITE IMAGERY



LAUREN C. TIERNEY, THEODORE A. SICKLEY, AND RYAN T. WILLIAMS, NGM STAFF

SOURCES: BRUCE FORBES, ARCTIC CENTRE, UNIVERSITY OF LAPLAND; GAS INFRASTRUCTURE EUROPE; EUROPEAN NETWORK OF TRANSMISSION SYSTEM OPERATORS FOR GAS; ANNA DEGTEVA AND OTHERS, *PASTORALISM: RESEARCH, POLICY AND PRACTICE*, 2013; ALVARO IVANOFF, NASA GODDARD SPACE FLIGHT CENTER; ARCTIC COUNCIL; ENERGY INFORMATION ADMINISTRATION; MINISTRY OF INDUSTRY AND ENERGY, RUSSIA; MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT, RUSSIA

Eighty-year-old Nina Khudi steps outside the family chum (above). Covered with reindeer skins in the winter, the teepee-like tent protects the family from blowing snow and biting cold. Pedava Puiko (below) throws a lasso made of braided strips of tanned reindeer skin over fleeing reindeer.

In spring, when snow and frozen rivers still favor sledding, the herds push rapidly north (above). In 2014 some 61,000 reindeer died (below) when unseasonable rain froze to thick ice that prevented grazing. After a couple of weeks without food, says Yuri Khudi, “they weaken and soon lie down and don’t get up.”

Sisters Vera and Sophia Khudi (walking) receive the "white carpet" treatment from Gazprom, the company that operates Bovanenkovo, as the herd crosses the gas field. The geotextile is supposed to make it easier for reindeer bulls to pull the sleighs across the road.

more eruptions were reported on the peninsula. One occurred near the camp of a herder.

BRIGADE 4 HAS A DEADLINE: a day and an hour when, by appointment with Gazprom, it is to cross the busiest road through Bovanenkovo. After two days of picking our way through an industrial maze, we finally reach the crossing place. On the concrete road, large trucks roll by every minute. Crossing is treacherous for both reindeer and herders.

"This is why we coordinate the road crossings with Gazprom," says Galina Mataras, director of a nongovernmental organization that represents the Nenets herders. "It's taken a lot of time and effort to make sure that the crossing is expedient and safe." At the appointed hour, traffic is stopped and a large swath of white geotextile fabric is unrolled across the road. The fabric eases the movement of sleighs across the concrete slabs.

For Gazprom the "white carpet" affair is an annual photo opportunity. A helicopter has flown in from Salekhard to deliver representatives of the company, the herders' own business enterprise, a couple of NGOs, the regional government, and the local press. As the reindeer caravan begins the crossing, Gazprom and the press document the event. Workers in crisp blue coveralls, with a silver Gazprom logo branded on their backs, line up on both sides of the white carpet to take pictures and get selfies with the herd.

"That's it!" announces Nyadma, after we've crossed the road at last. "No more roads or pipelines. We don't have to rush and break camp every night now. We can take our time fishing.

"It wasn't easy, when Gazprom arrived," he goes on. In the early years at Bovanenkovo, after construction began in the 1980s, rail lines, pipelines, roads, sandpits, and buildings were popping up everywhere. "We felt trapped, like there was no place for us on our ancestral land," Nyadma says. "We understand that the country needs natural gas, and once the main construction stopped, we figured a way around this mess. We can cope with it." He pauses. "As long as they don't build any more roads or pipelines."

An hour later we stop on a high knoll, and Nyadma peers through his field glasses, scouting the pass ahead. His sons Gosha and Ilya pull up in their sleighs. Now everybody is looking in the same direction through their binoculars, talking agitatedly in Nenets. In the distance a new dirt road scars the tundra.

Later we discover a new feeder line parallel to the road; connecting a gas well to a compressor, it cut across our next campsite. Neither the road nor the pipe were here three summers ago, when the brigade last passed through. The Nenets hadn't been alerted to their construction. They shouldn't be there, Nyadma says.

AT THE CAMPSITE, between the road and the pipeline, I discover the source of the distant hum I heard a few days ago. Just a few hundred yards away now, it's a crimson ball of fire belching out of a sooty pipe—a gas flare that serves to release excess pressure from the pipeline. In the swirling

As Brigade 4 prepares to break camp and move to a new pasture, Natalia Puiko, 18, holds a rope with other women to corral the reindeer. The men will pick out bulls from the herd to pull the sleighs.

air around the flames, tundra, water, and sky melt into a mirage of browns, greens, and blues. The hum has become a powerful roar that drowns out most other sounds.

And from this vantage point, the notion that the Nenets reindeer herders can coexist in a "balanced" way with oil and gas development—an idea I heard consistently from Gazprom officials, the regional government, NGOs, and the herders themselves—seems an illusion. A new gas processing facility, with its associated roads and pipelines, is scheduled to come on line at Bovanenkovo in the next couple of years. Two new railroad branches are being constructed to connect hubs at Bovanenkovo and Payuta in western Yamal with oil and gas terminals on the east coast. Those railway lines will cut across the migration routes of most of the Nenets herds. Even more troubling for Brigade 4, a new gas field called Kruzenshternskoye is projected to come on line in the early 2020s on the Kara Sea coast. It will encroach on exceptionally rich pastures.

As I'm pondering all this, the roaring gas flare abruptly shuts off. The thermals dissipate around the pipe, and the landscape beyond settles back into its familiar shapes and colors. Around me, the next generation of Nenets herders are practicing their lassoing skills on sleighs, dogs, and each other, while the next generation of Nenets mothers feed their dolls in makeshift toy chums. In the silence, the familiar sounds return—the low voices of the herders, the cries of the children and dogs, the clicks of the reindeer hooves. For a moment, everything seems all right again on the edge of the world. □

Evgenia Arbugaeva photographed the Arctic resource boom for the March 2016 issue. *Archipelago of Hope,* **Gleb Raygorodetsky's** book on indigenous peoples and climate change, will be published in November.

Reindeer meat is a rich source of micronutrients, minerals, and vitamins, and a staple of the Nenets diet. When they slaughter an animal, they like to eat the meat raw, while it's still warm. But during a 2016 outbreak of anthrax on southern Yamal, they curtailed that practice.

Wearing a curtain and a cardboard crown, Kristina Khudi becomes the “tundra princess” in the Nenets camp near the Kara Sea. The eight-year-old says her happiest time is summer, when a helicopter sent by Gazprom and the regional government brings her and other kids home from school to their migrating families. In fall, when the chopper returns, some kids hide in the tundra.

On All Floors

Every weekend, apartment hallways in Manila's Tondo district teem with life—and hope.

In a housing project in the Philippines, near Manila's shuttered Smokey Mountain dump, children and grandchildren of former workers frolic in hallways and stairwells. Most housing in this area is flimsy, but this structure is sturdy and permanent.

By Jeremy Berlin
Photographs by Mariusz Janiszewski

The paint is peeling. The floors are grimy. The basketball nets are frayed. And no one seems to mind.

Children laugh and play games. Men take siestas. Roosters strut down the hallway. In one of the world's most densely populated cities, life's rich pageant plays out on every floor.

That's what Polish photographer Mariusz Janiszewski found last year when he visited a government housing project in Barangay 128, a section of Manila's Tondo district. Built in the 1990s near Smokey Mountain—an internationally infamous dump that once housed more than two million tons of trash—it's still home to many of the site's former workers.

Janiszewski says he'd shot in the Philippines before but always in a "typical documentary" style. This time he had something else in mind.

"I wanted to show how daily life looks in an overpopulated place like Manila," he says, "and how it's lived in semi-open spaces and stairwells." To do that, he "chose not to take pictures from a variety of perspectives" but to "stay in one place and wait for the surprising and unpredictable."

Each floor "looked like an identically designed stage," he says, but soon revealed a distinct milieu: women cooking, men gambling, children playing cards. Janiszewski returned each weekend to document these living tableaux, capturing scenes of family, friends, and neighbors bonding.

Mary Racelis, a social anthropologist at Ateneo de Manila University, says that sense of community is key in a place like Tondo. Many residents are informal settlers, once called squatters. Long considered second-class citizens, they've often been denied jobs, housing, and basic services.

"Over the years these people have formed networks that have enabled them to survive and find new opportunities," she says. With the help of NGOs and leftist political groups, they've been able to organize effectively, raise their voices, and demand better living conditions.

What matters here, she adds, as anywhere else, is "location, location, location ... The city is where jobs are ... Those who have been moved by the government to distant relocation sites have found that they cannot survive there."

Many of the available jobs today are in the informal sector, which includes Manila's thriving drug cartels. For other employment opportunities, completing high school or college is crucial.

Regardless of education level, the residents of Barangay 128 have no shortage of two precious commodities: hope and resilience.

The most important thing that flows from these pictures, suggests Janiszewski, is that "despite the odds, people here can enjoy life, and they often have a smile on their faces. I've always admired that." ☐

Boys smoke cigarettes and relax on a bicycle that's been converted into a rickshaw. Bernardita Churchill, a Filipino historian, says it's rare to see children this young smoking in the Philippines.


AVELIVES

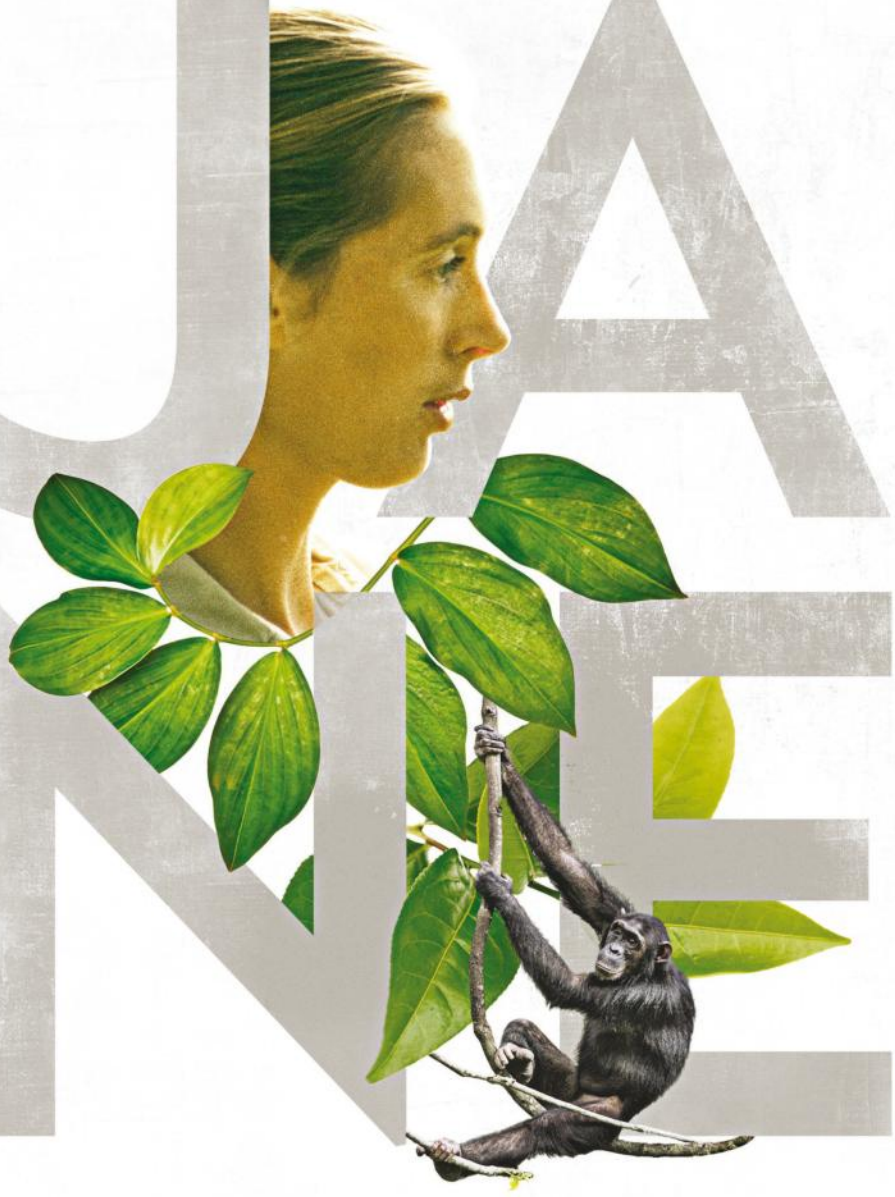
Young people play a game of cards, using dried pasta in lieu of money. Photographer Mariusz Janiszewski says gambling and group games are common activities in this part of Manila.

A rooster — likely a fighting cock — walks by residents in a hallway. Cockfighting is a popular sport in the Philippines, but it's permitted only on Sundays, holidays, and during fiestas.

FROM THE DIRECTOR OF

THE KID STAYS IN THE PICTURE AND **KURT COBAIN: MONTAGE OF HECK**

JANE



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If You Own or Previously Owned, Purchased, or Received as a Gift or Customer Service Exchange Certain Sony Xperia Smartphones and Tablets, You Could Get Benefits from a Class Action Settlement.

Para ver este aviso en español, visita www.XperiaWaterproofSettlement.com

A proposed class action settlement has been preliminarily approved by a Court against Sony Mobile Communications (USA), Inc. and Sony Electronics, Inc. (collectively "Sony") concerning certain Xperia smartphones and tablets ("Mobile Devices") in *Landes v. Sony*, 2:17-cv-2264-JFB-SIL (E.D.N.Y.). Those included in the settlement have legal rights and options that must be exercised by certain deadlines.

What is the lawsuit about?

The lawsuit alleges that certain Mobile Devices are not waterproof and are not capable of ordinary underwater use. Sony denies the allegations and that the Mobile Devices are defective. The Court did not decide which side was right. Instead, the parties decided to settle.

Am I included in the proposed settlement?

Subject to certain limited exclusions, you are included if as of **August 3, 2017**,

- You own(ed), purchase(d), or received as a gift or as a customer service exchange a Mobile Device that was
- Manufactured, marketed, sold and/or distributed by Sony Mobile Communications (USA), Inc. in any of the fifty States, the District of Columbia and Puerto Rico.
- The class includes persons, entities and/or organizations.

The Mobile Devices are certain Xperia mobile smartphone and tablet models. For a specific list, visit the website, or call **1-844-367-8807**.

What does the settlement provide?

The proposed settlement provides for: (1) a warranty extension for damage resulting from water intrusion by an additional 12 months for Mobile Devices that are still in-warranty and six months for those Mobile Devices that are out-of-warranty, both measured as of the date of the issuance of the Preliminary Approval Order; (2) changes to packaging, labeling and advertising intended for end users in the United States relating to "waterproof" or substantially identical terms to "water resistance" or its substantial and/or functional equivalent for Mobile Devices currently being sold by Sony or any newly-introduced models with certain IP ratings; and (3) a claim process for eligible Class Members who previously had timely claims for water-related damages denied by Sony for their in-warranty Mobile Devices in which Sony will pay 50% of the at-issue Manufacturer's Suggested Retail Price for the applicable Mobile Device. Class counsel will file a request for attorneys' fees, costs and expenses, and Class Representatives' awards to be paid by Sony. The motion will be posted on the website after it is filed.

What are my options?

Stay in the Class and receive settlement benefits. You automatically receive a warranty extension but, if applicable, **must** submit a claim to receive reimbursement benefits. The deadline to submit Claim Forms is **January 30, 2018**.

If you do nothing, you stay in the class and still get the warranty extension and other benefits, but will not be able to sue Sony or receive reimbursement benefits.

You can exclude yourself if you don't want to be part of the settlement. You won't get any settlement benefits, but you keep the right to sue Sony about the issues in the lawsuit. You must mail to the settlement administrator your written request for exclusion postmarked by **November 1, 2017.**

You can object to all or part of the settlement by **November 1, 2017**, if you don't exclude yourself. The full notice describes how to obtain settlement relief, exclude yourself, and object.

The Court will hold a fairness hearing on December 1, 2017 at 1:30 p.m. EST in courtroom 1020 in federal court, 100 Federal Plaza, Central Islip, NY 11722 to (a) consider whether the proposed settlement is fair, reasonable, and adequate, and (b) decide the plaintiffs' lawyers' request for fees, costs and expenses of up to $1,000,000.00 and awards for each of the Class Representatives of up to $1,000.00. You may appear at the hearing, but you are not required to and you may hire an attorney to appear for you, at your own expense.

For more information or a claim form call or visit the website.

1-844-367-8807
www.XperiaWaterproofSettlement.com

FURTHER

A GLIMPSE OF WHAT'S NEW AND NEXT

UNDER THE WAVES

How close can you really get to two monster squid fighting?

Very close, it turns out. This month National Geographic's newest experience, "Ocean Odyssey," opens in Times Square in New York City, bringing visitors face-to-face with humpback whales, great white sharks, and a pair of Humboldt squid locked in ferocious battle.

The experience draws on the latest research of marine biologist David Gruber, a National Geographic emerging explorer who specializes in bioluminescence and biofluorescence, and other underwater phenomena that humans rarely see.

Walking through the interactive encounter is in many ways better than the real thing. An Academy Award-winning team uses ultrahigh-resolution photo animation, video mapping, and audience-responsive walls and floors to provide more sights and sounds than if you were swimming through the Pacific yourself. Starting October 6, you can visit the immersive experience—and leave completely dry.

Go FURTHER into National Geographic's "Encounter: Ocean Odyssey" in New York's Times Square. Buy tickets at *NatGeoEncounter.com.*

IMAGE: RENDERING BY NATIONAL GEOGRAPHIC ENCOUNTER: OCEAN ODYSSEY

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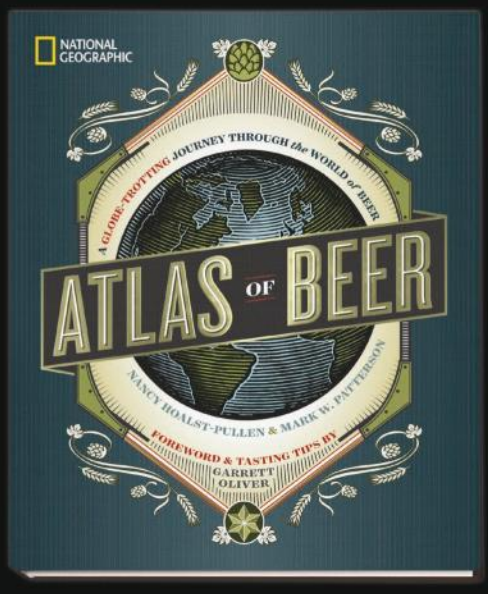

This richly illustrated atlas—and travel guide—explores beer history, geography, and trends on six continents. Travel tips include lists of the best breweries, unique brewing traditions, and beer festivals around the globe.

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